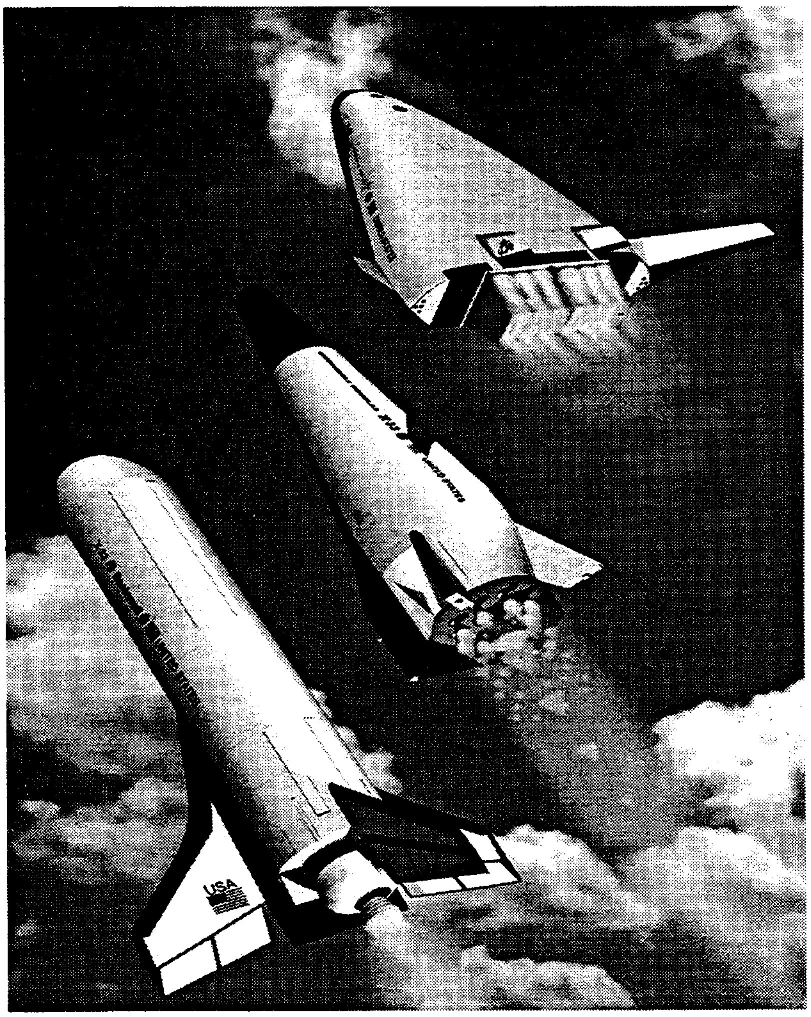
National Aeronautics and
Space Administration

Final

X-33

Programmatic Environmental Assessment: Vehicle and Technology Demonstration Concepts



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X-33 Programmatic Environmental Assessment: Vehicle and Technology Demonstration Concepts

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Abstract

The purpose of this Environmental Assessment (EA) is to support the program continuation decision and proposed action to initiate the design/demonstration phase (Phase II) of an Advanced Technology Demonstrator Vehicle, Experimental-Thirty Three (X-33) as part of NASA's Reusable Launch Vehicle (RLV) Technology Program. The Program will implement the National Space Transportation's policy designed to support Government and private sector decisions by the end of the decade on development of an operational, next-generation reusable launch system. Phase II consists of final design, fabrication, assembly, and test of the X-33. Technical, logistics, operations, and business plans proposed by offerors in response to NASA's Cooperative Agreement Notice (CAN) 8-3, "X-33 Phase II: Design and Demonstration," issued April 1996 (MSFC 1996) will be used by NASA to select an Industry Partner to implement Phase II.

Environmental implications of this selection are evaluated in this assessment. Issues contingent on the selection of Phase II Industry Partner will be evaluated in a second environmental document. Environmental analyses to date have identified no issues, which would preclude the selection of any of the proposed technologies. Neither were any site specific issues identified that would preclude the use of any of the three alternative sites proposed for flight operations.

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List of Abbreviations and Acronyms

45 SW	U.S. Air Force 45th Space Wing
ac	acre(s)
AF	Air Force
AFB	Air Force Base
AFFTC	Air Force Flight Test Center
AFMC	Air Force Materiel Command
Al-Li	aluminum-lithium
APCD	Air Pollution Control District
AQCR	Air Quality Control Region
ARC	Ames Research Center
ARTCC	Air Route Traffic Control Center
AST	aboveground storage tank
AT&SF	Atchison Topeka and Santa Fe
ATCALS	Air Traffic Control and Landing Systems
AVEK	Antelope Valley East Kern (Water District)
BCWRD	Brevard County Water Resources Department
BLM	Bureau of Land Management
BMP	Best Management Practices
BMDO	Ballistic Missile Defense Organization
Btu	British thermal unit
C	celsius
C4	Command, Control, Communications, and Computer Systems
Cal-OSHA	California Occupational Safety and Health Administration
CAN	Cooperative Agreement Notice
CCAS	Cape Canaveral Air Station
CFR	Code of Federal Regulations
cm	centimeter
CNG	compressed natural gas
CNPS	California Native Plant Society
CNS	Canaveral National Seashore
CO	carbon monoxide
COE	Corp of Engineers
cps	cycles per second
dB	decibels
dBA	decibel, weighted to the A-scale
dBC	decibel, weighted to the C-scale

List of Abbreviations and Acronyms (Continued)

DC-X	Delta Clipper - Experimental
DC-XA	Delta Clipper - Experimental Advanced
DES	Digital Encryption Standard
DFRC	Dryden Flight Research Center
DNH	Division of Natural Heritage
DOD	Department of Defense
DOI	Department of Interior
DOT	Department of Transportation
DSN	Defense Switch Network
EA	Environmental Assessment
EAFB	Edwards Air Force Base
EELV	evolved expendable launch vehicle
EIS	Environmental Impact Statement
EJ	Environmental Justice
EO	Executive Order
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ER	Eastern Range
ERD	Environmental Resources Document
ES/QD	explosive safety/quantity distance
ET	External Tank
F	Fahrenheit
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FDEP	Florida Department of Environmental Protection
FEC	Florida East Coast
FONSI	Finding of No Significant Impact
FPL	Florida Power and Light
FSS	Fixed Service Structure
ft	feet
FTS	Federal Telephone Service
gal	gallon
GLOW	gross lift off weight
GOCO	Government-owned/Contractor-operated
gpd	gallons per day
GSE	ground support equipment
ha	hectare(s)

List of Abbreviations and Acronyms (Continued)

HDPE	high density polyethylene
HELSTF	High Energy Laser System Test Facility
Hz	hertz
ICBM	Intercontinental Ballistic Missile
IFR	Instrument Flight Rule
IIP	Instantaneous Impact Prediction
ILS	Instrument Landing System
in	inch
IRP	Installation Restoration Program
ITF	Integrated Test Facility
ITL	Integrate/Transfer/Launch
JPC	Joint Propellants Contractor
JPL	Jet Propulsion Laboratory
JSC	Lyndon B. Johnson Space Center
kg	kilogram
km	kilometer(s)
km/hr	kilometers per hour
kpa	kilopascal
KSC	John F. Kennedy Space Center
kV	kilovolt
kVA	kilovolt ampere
kWh	kilowatt hour
L	liter(s)
LaRC	Langley Research Center
lb	pound(s)
LBSC	Launch Base Support Contractor
LC	Launch Complex
L_{dn}	day-night average sound level
LeRC	Lewis Research Center
LETF	Launch Equipment Test Facility
LH_2	liquid hydrogen
LOX	liquid oxygen
Lpd	liters per day
LPS	Launch Processing System
m	meters
MDD	Mate/Demate Device
mgd	million gallons per day

List of Abbreviations and Acronyms (Continued)

MHz	megahertz
mi	mile(s)
MINWR	Merritt Island National Wildlife Refuge
mLd	million liters per day
MLP	Mobile Launch Platform
MPa	megapascal
mph	miles per hour
MSBLS	Microwave Scanning Beam Landing System
MSFC	George C. Marshall Space Flight Center
MVA	megavolt-ampere
MW	megawatts
N/m^2	Newton per square meter
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NASP	National Aero-space Plane
NAWC	Naval Air Warfare Center
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Radar
NHB	NASA Handbook
NMDGF	New Mexico Department of Game and Fish
NMFRCD	New Mexico Forestry Resource Conservation Division
NMNHP	New Mexico Natural Heritage Program
NO_2	nitrogen dioxide
NOI	Notice of Intent
NOTAM	Notices to Airmen
NPS	National Park Service
NRHP	National Register of Historic Places
NTC	National Training Center
O_3	ozone
O&C	Operations and Checkout
O&M	Operations and Maintenance
OASPL	overall sound pressure level
ORC	Orogrande Range Camp
OSHA	Occupational Safety and Health Administration
Pa	Pascal
PAFB	Patrick Air Force Base
PAMS	Permanent Air Monitoring System

List of Abbreviations and Acronyms (Continued)

PAPI	Precision Approach Path Indicator
PCA	Positive Control Airspace
PCB	polychlorinated biphenyls
PIRA	Precision Impact Range Area
PL	Phillips Laboratory
PM_{10}	particulates less than 10 microns in size
psf	pounds per square foot
psi	pounds per square inch
PVC	polyvinyl chloride
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RCRC	Rhodes Canyon Range Center
RLV	Reusable Launch Vehicle
ROI	region of influence
RP	rocket propellant
RSS	Rotating Service Structure
RTTS	return to takeoff site
SCC	John C. Stennis Space Center
SCS	Soil Conservation Service
SDIO	Strategic Defense Initiative Organization
SEDAB	Southeast Desert Air Basin
SHPO	State Historic Preservation Office
SLC	Space Launch Complex
SLF	Shuttle Landing Facility
SMAB	Solid Motor Assembly Building
SO_2	sulfur dioxide
SPIF	Spacecraft Integration Facility
sq	square
SR	State Road/State Route
SRB	Solid Rocket Booster
SRC	Stallion Range Center
SSTO	single-stage-to-orbit
STP	Sewage Treatment Plant
TACAN	tactical air navigation
TECOM	U.S. Army Test and Evaluation Command
TPS	thermal protection system
TRI	Toxic Release Inventory

List of Abbreviations and Acronyms (Continued)

TSF	Test Support Facility
U.S.	United States
UHF	ultrahigh frequency
USAF	United States Air Force
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USN	United States Navy
UST	underground storage tank
UV-B	ultraviolet-B
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VFR	Visual Flight Rule
VHF	very high frequency
VOC	volatile organic compounds
VOR/TAC	Very High Frequency Omni Range/Tactical Air Navigational
VTHL	vertical takeoff/horizontal landing
VTVL	vertical takeoff/vertical landing
WAPA	Western Area Power Administration
WFF	Wallops Flight Facility
WL	USAF Wright Laboratories
WMA	Waste Management Authority
WSMR	White Sands Missile Range
WSNM	White Sands National Monument
WSSH	White Sands Space Harbor
WSTF	White Sands Test Facility
WWTP	Wastewater Treatment Plant
X-33	Experimental-33

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1.0 Introduction

1.1 Purpose and Proposed Action

The purpose of this Environmental Assessment (EA) is to support the program continuation decision and proposed action to initiate the design/demonstration phase (Phase II) of an Advanced Technology Demonstrator Vehicle, Experimental-Thirty Three (X-33) as part of the National Aeronautics and Space Administration's (NASA) Reusable Launch Vehicle (RLV) Technology Program. This program will implement the National Space Transportation Policy, specifically Section III, paragraph 2(a): "The objective of NASA's technology development and demonstration effort is to support Government and private sector decisions by the end of this decade on development of an operational next-generation reusable launch system." Phase II would consist of final design, fabrication, assembly, and test of the X-33 spaceplane. The X-33 spaceplane will be flight tested using an expansion of the flight envelope (maximum speeds necessary to demonstrate the technique required for orbital capability around the Earth) to demonstrate "aircraft like" operations. Technical, logistics, operations, and business plans proposed by offerors in response to NASA's Cooperative Agreement Notice (CAN) 8-3, "X-33 Phase II: Design and Demonstration," issued April 1996 (MSFC 1996) will be used by NASA to select an Industry Partner to proceed with NASA to implement Phase II.

1.2 Background

1.2.1 RLV Program

For many years, the United States (U.S.) has recognized that space transportation costs must be significantly reduced so that the Nation can afford to continue to expand its exploration, development, and use of space. In NASA's *Access to Space Advanced Technology Team Final Report,* a single-stage-to-orbit (SSTO) transportation architecture was recommended as a prime candidate for the next generation of reusable space transportation systems which could meet future requirements with significant reductions in annual operating costs (NASA 1993). On August 5, 1994, President Clinton's Space Transportation Policy assigned NASA as the lead Agency for advanced technology development and demonstration for the next generation of reusable launch systems. Work involved to support this effort would focus on the Advanced Technology Demonstrator Vehicle X-33.

Proposed implementation of the X-33 Program has been divided into three phases. Phase I, which was the purpose of CAN 8-1 (MSFC 1995-A), required 15 months to accomplish preparation of concept definition and preliminary design of the reusable advanced technology demonstrator system, X-33. The X-33 includes the flight spaceplane, supporting ground based technology demonstrations, and any required ground and flight support systems. Based on results of Phase I and evaluation of proposals received in response to CAN 8-3, an Industry Partner will be selected for Phase II, if a decision is made to continue the program.

In March 1995, NASA signed three Cooperative Agreements for Phase I. The X-33 Cooperative Agreements were signed with Lockheed-Martin Skunk Works, Palmdale, California; McDonnell-Douglas Aerospace, Huntington Beach, California; and Rockwell International Corporation, Space

Systems Division, Downey, California. The Office of Space Access and Technology at NASA Headquarters in Washington, DC, manages the RLV Technology Program. Marshall Space Flight Center (MSFC), Huntsville, Alabama, is host center for the X-33 Program. The U.S. Air Force (USAF) supports NASA in management of test flight and operations. Also, various Government laboratories would participate with industry members to apply the technology developed toward this next-generation launch system. The following Government laboratories have been identified, to date, with existing expertise to be of assistance in expediting the success of this program: MSFC in Huntsville, Alabama; Ames Research Center (ARC) in Santa Clara County, California; Lewis Research Center (LeRC) in Cleveland, Ohio; Langley Research Center (LaRC) in Hampton, Virginia; Johnson Space Center (JSC) in Houston, Texas; Jet Propulsion Laboratory (JPL) in Pasadena, California; Kennedy Space Center (KSC) in Brevard County, Florida; Stennis Space Center (SCC) in Hancock County, Mississippi; USAF Phillips Laboratory (PL) on Edwards Air Force Base (EAFB) near Lancaster, California; and USAF Wright Laboratories in Cleveland, Ohio. Other Government centers are contributing to the program as well.

Enabling an SSTO system is the ultimate goal of the RLV Technology Program. An SSTO system would operate in an "aircraft-like" mode; (i.e., the entire spaceplane with all fuel tanks and engines are launched and returned to earth in one unit, unlike the Space Shuttle which ejects the external tank (ET) and two reusable boosters during ascent). No stages will be dropped with an SSTO system. To meet the technical and programmatic challenges of development of a fully reusable SSTO vehicle, key advanced technologies in reusable systems must be explored. Therefore, specific goals of Phase II of the RLV Technology Program are to demonstrate improved operability, safe abort, reusability, and affordability through ground and flight tests. If Phase II is fully successful, it will enable a low-risk, low-cost development of a commercially operated RLV system or spaceplane. Advanced technologies would also be used to enhance operation and performance of existing space vehicle fleet(s), where possible. Specifically, the experimental flight portion of the program would be used to verify full-scale system operability in "real world" environments.

As part of the integrated planning for this new program and in consideration of NASA's environmental responsibility under the National Environmental Policy Act (NEPA), this programmatic EA has been prepared for the activities required to support the X-33 Program. Program elements are described in NASA's CAN 8-3, issued April 1996, and significant portions of the following text are taken directly from this program document (MSFC 1996).

The X-33 will demonstrate critical technologies needed for orbital SSTO vehicles in realistic operational environments. To the extent practical, the X-33 will be tested in ascent and reentry flight environments of a full-scale SSTO vehicle. In addition, X-33 will focus on those operational issues which are critical to development of reliable, low-cost, reusable space transportation. The X-33 will incorporate more advanced materials with weights and margins equivalent to those required by an SSTO vehicle. The X-33 supportability goals are key to lower cost system operations. The operability and performance demonstrated by the X-33 will provide necessary data to establish detailed requirements for a future operational SSTO vehicles. The X-33 Program has an unprecedented opportunity to systematically flight test a realistic, full-component prototype spaceplane in a stepwise manner. Initial flight tests would be conducted entirely within Government-controlled test ranges to ensure reliability, reusability and performance prior to long-range flights (up to approximately 1900 km (1200 mi)) at high speeds approaching Mach 15 (15 times the speed of sound or 18,000 km/hr (11,000 mph)).

Phase II will consist of final design, fabrication, assembly, and test of the X-33 spaceplane. The X-33 spaceplane will be flight tested using an envelope expansion flight program to demonstrate aircraft-like operations. Flight testing will be accomplished using an appropriate test range for primary operations, including takeoff and initial on-range flight tests, and return site for checkout and reflight. It is anticipated that Phase II will be completed by the year 2000. Phase II will also develop all necessary data to support an informed program continuation decision at the completion of the phase. Data will include program planning and a detailed business plan for Phase III and an operational RLV system designed to a level sufficient to provide a high confidence cost estimate and show that all program risks have been identified and are acceptable.

Phase II is focused towards demonstrating technology to build RLV's with aircraft-like operations. Phase III will include design, manufacture, and operation of the RLV system. Execution of Phase III is an industry decision. In Phase III, the Government would become a customer, not an owner or operator, of the launch system(s).

A companion RLV program focused on a test vehicle exploring aircraft-like operations named the DC-X for Delta Clipper-Experimental which was also an unpiloted, single-stage vehicle. Its purpose was to provide early demonstration of new technologies needed for a reliable, affordable RLV that could be operated commercially by American industry with NASA as one of its customers. Validation with static test firings at the U.S. Army's White Sands Missile Range (WSMR), New Mexico; NASA's White Sands Test Facility (WSTF), a tenant on WSMR; and launch and flight test activities at the White Sands Space Harbor (WSSH) on WSMR were successfully conducted by the Ballistic Missile Defense Organization (BMDO) (formerly Strategic Defense Initiative Organization (SDIO)) and the Air Force Phillips Laboratory. No significant environmental impacts were expected as a result of the EA prepared by SDIO (SDIO 1992).

The follow-on program to the DC-X is the responsibility of NASA and has been named the DC-XA for Delta Clipper - Experimental Advanced. On June 7, 1996, the DC-XA was renamed the "Clipper Graham" in honor of the late Lt. General Daniel O. Graham, the original proponent of SSTO vehicles. Specific test objectives of the Clipper Graham flight series tests are forerunners and complementary to those of the X-33 and include:

- verify functional integrity and operational suitability of a:
  - composite liquid hydrogen (LH_2) tank
  - composite intertank
  - aluminum-lithium (Al-Li) liquid oxygen (LOX) tank
  - auxiliary propulsion system under typical flight conditions;
- verify functional compatibility of Clipper Graham vehicle, flight operations control center, and ground support services under launch and flight conditions;

- verify key operability and supportability features of hardware and software under launch and flight conditions; and

- determine operational characteristics and flight readiness of the Clipper Graham vehicle.

A series of flight tests with an approximate maximum range of 3 km (1.8 mi) will be conducted at WSMR during the summer of 1996 to validate important new technologies and enhance the reliability and success of other RLV programs such as the X-33. Data from the Clipper Graham program will be universally available to any successful competitor continuing to work on Phase II of the X-33 Program. Environmental considerations for the Clipper Graham were essentially the same as those previously documented for the DC-X Test Program, and the DC-X EA results were readopted for the DC-XA, now Clippper Graham (MSFC 1995-C).

1.2.2 X-Plane Program

The U.S. X-Plane Program has evolved from being the first rocket-powered airplane to break the sound barrier (the X-1 on October 14, 1947) and included over 30 different major research designs, although not all were developed into flying prototypes (Hallion 1984, Miller 1988, DFRC/EAFB 1994-A/B, DFRC/EAFB 1995). As the program progressed, other non-rocket-powered experimental aircraft were built and tested. These aircraft included: a range of vertical takeoff and horizontal landing (VTHL) vehicles; smaller, propeller-driven reconnaissance vehicles; and a series of unmanned missile testbeds of both single and multistage designs. Although the program grew to include conventional propeller-driven aircraft, all designs had in common the aspect of being highly valuable research tools for advancement of aerodynamics and astronautics.

Accomplishments of the X-Plane family have been many. The program included: (1) the first aircraft to break the sound barrier; (2) the first aircraft to use a variable-sweep-wing in flight; (3) the first to fly at altitudes in excess of 30,000, 60,000, and 90,000 m (100,000, 200,000 and 300,000 ft); (4) the first to use exotic alloy metals for primary structure; (5) the first to test gimbaled jet and rocket engines; (6) the first to use jet-thrust for launch and landing; (7) the first to fly three, four, five, and six times the speed of sound; (8) the first to test boundary-layer-airflow control theories over an entire wing at transonic speeds; (9) the first to successfully complete a 180 degree turn using a post-stall maneuver; and (10) the first missile to reach an intercontinental flight range.

The majority of testing for the X-Plane family has occurred at EAFB (formerly known as Muroc Army Air Field). Hosts within EAFB include the Air Force Flight Test Center (AFFTC) and Dryden Flight Research Center (DFRC). Other sites which have served as X-Plane testing sites include: LaRC and ARC; various Government-owned ships; WSMR, New Mexico; Wright-Patterson AFB, Ohio; Cape Canaveral Air Station (CCAS), Florida; Pinecastle AFB, Florida; Buffalo, New York; and the National Aviation Facilities Experimental Center in Atlantic City, New Jersey. EAFB has seen more X-Plane programs and test flights than any other similar facility in the U.S.

As with every research program testing prototype equipment, the X-Plane Program has not been without technical glitches and equipment failures. Since the beginning of the program's manned flight operations in 1946, approximately 15 major accidents and 4 fatalities (pilots) have been associated with manned vehicle tests. Three of these fatalities were from the X-2 Program, flown between 1952 and 1956, and the remaining fatality happened in 1967 during an X-15 research flight. Stringent range safety controls have resulted in no civilian property damage losses or fatalities being reported as a result of any X-Plane Program accident. Given the overwhelming number of test flights, the small number of accidents which resulted in loss of aircraft or life can be considered a remarkable program achievement. Table A-1 in Appendix A provides key information about each plane tested in the X-Plane series of vehicles.

Another member of the X-Plane Program would be the X-33. As a reusable spaceplane, the X-33 continues the research line developed by various components of the X-Program, such as the X-10 which tested cruise missile components; the X-12, the Atlas B missile which tested one-and-one-half propulsion staging and obtained the first intercontinental flight distance for a U.S. missile; the X-15 which explored the problems of space and reentry at high speeds (Mach 6) and altitudes; the X-17 which explored high Mach effects on reentry vehicles; and the X-23A which was the first maneuvering lifting reentry vehicle. The X-17 was a multistage rocket design which transported various reentry vehicle configurations to very high altitudes to examine their reentry characteristics. The X-23A was launched by a modified intercontinental ballistic missile (ICBM) and utilized a "lifting body" design to glide back to earth. Information acquired from the X-23A was instrumental in later development of the Space Shuttle.

1.3 Need and Scope

This EA was prepared in accordance with the requirements of NASA Handbook (NHB) 8800.11, "Implementing the Provisions of the National Environmental Policy Act (NEPA)." NASA intends that the EA be part of the overall evaluation process, selection of an Industry Partner, and preparation of a Cooperative Agreement to accomplish the X-33 Phase II: Design and Demonstration Program. The EA addresses potential alternative spaceplane concepts, propulsion systems, and primary (primary takeoff and operations) sites. Alternate site(s) with intervening off-site test flight corridors are described generically, and preliminary environmental evaluations and issues are noted. Following Industry Partner selection, if the decision is made to continue, the program will become fully defined and preference and alternative corridors will be evaluated in comprehensive detail in a second environmental document. No new manufacturing facilities are contemplated by NASA at this time. Therefore, none will be addressed in this EA.

2.0 Description of Proposed Action and Alternatives

2.1 Proposed Action

The proposed action for analysis in this EA is the decision to implement Phase II of the X-33 RLV Advanced Technology Demonstrator Program. The planned program will combine ground and flight demonstrations. The X-33 concept involves a remotely piloted, subscale spaceplane, approximately one-half the size of a full scale SSTO capable of carrying payloads and crew into orbit. Technology demonstration flight tests are a key part of Phase II. Recommendations for primary locations for these activities have been provided to NASA from the three Phase I Industry Partners. From the recommendations, data and concepts developed during Phase I, program alternatives have been considered in the following areas: spaceplane concepts; propulsion systems and primary flight test operations facilities (facilities for spaceplane assembly, verification, data acquisition and analysis, initial takeoff and on-range flight testing, and primary site for spaceplane takeoff into off-site test flight corridors). Alternate flight test operations (landing and return sites for flight testing with minimal operational support capability) and test flight corridors will be evaluated generically to identify and scope the magnitude of relevant environmental issues.

2.1.1 Specific Technical Objectives

Specific technical objectives to be met in Phase II are to:

- conduct flight and ground tests necessary to reduce business and technical risks which are currently barriers to privately financed development and operation of a next generation space transportation system;

- design and test the X-33 spaceplane, subsystems, and major components and ensure traceability (technology and general design similarity) and scaleability (directly scaleable weights, margins, loads, design, fabrication methods, and testing approaches) to a full scale SSTO system;

- demonstrate key "aircraft like" operational attributes required for a cost-effective SSTO system. Minimum key demonstrations include operability (e.g., increased thermal protection system (TPS) (i.e., a protection system on areas of the spaceplane subject to temperature extremes) robustness, weather, etc.), reusability, affordability, and safe abort; and

- verify full-scale systems operability and performance in "real world" environments.

2.1.2 Key Technology Requirements

Successful development of a fully reusable SSTO vehicle or spaceplane depends on achieving more maturity for and demonstrating the following key technologies:

- reusable cryogenic tank system, including the tank(s) for LOX and LH_2, cryogenic insulation, and integrated TPS;

- composite primary spaceplane structures with integrated TPS for both low and high temperatures;

- long life and low maintenance TPS;

- relative merits of existing propulsion systems and preferred propulsion system for meeting reuse, cost, and operations requirements of X-33 and RLV configurations;

- spaceplane health monitoring to facilitate inflight systems monitoring and postflight failure identification; and

- autonomous flight control of checkout, takeoff, ascent, flight, reentry, and landing for an uncrewed, remotely piloted spaceplane.

2.1.3 Specific Flight Test Objectives

The Advanced Technology Demonstration test flights will be designed to demonstrate the following:

- interaction of engines, airframe, and launch pad at takeoff;
- safe return to the takeoff site, in the event of an abort;
- automated landing at a designated point on the runway;
- the capability to achieve low operational cost; and
- "aircraft-like" operations.

2.1.4 Schedule

The X-33 Program schedule is shown in Figure 2.1-1. The schedule is divided into three phases. Phase I began in January 1995 and will continue through June 1996. X-33 Concept Definitions and Designs and this EA were prepared during this phase. Phase II, the X-33 Development/ Operations Phase, is planned to be initiated in July 1996, following execution of a Cooperative Agreement between NASA and the Industry Partner selected as a result of evaluation of proposals submitted in response to CAN 8-3. Operational RLV development will take place in Phase III. Phase III will begin in the year 2000, with emphasis on commercial development of an SSTO spaceplane.

2.2 Program Description

Due to budget and schedule requirements set forth by NASA in CAN 8-3, maximum use of existing facilities with minimum modifications or additions to existing facilities is anticipated. Many of the activities described below will be conducted in temporary, mobile facilities such as trailers and with potentially transportable takeoff support equipment. Basic elements of the X-33

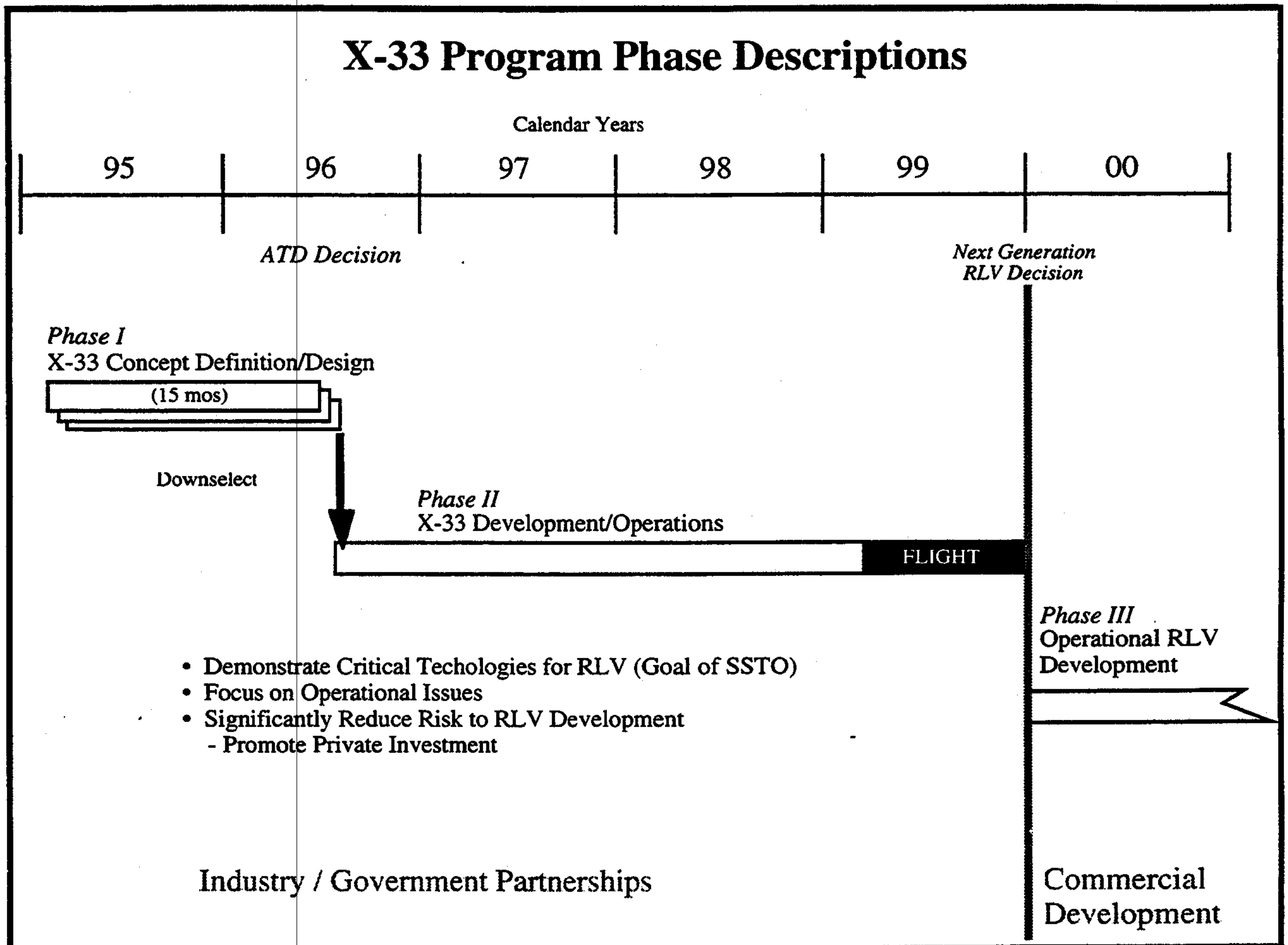


Figure 2.1-1. X-33 Program Phase Descriptions

Advanced Technology Demonstrator Program are shown in Figure 2.2-1 with potential major support installations shown in Figure 2.2-2.

2.2.1 Government Elements

Several major elements of the program are anticipated to be performed at Government installations as requested and negotiated by the selected Phase II Industry Partner. These activities may include research and development (R&D) of such key technologies as:

- Reusable cryogenic tank system
- Composite primary spaceplane structures
- Improved thermal protection systems
- Improved spaceplane health monitoring systems
- Autonomous flight control
- Aerodynamic and aerothermodynamic characterization
- Rocket propulsion
- Specialized computer modeling and simulations

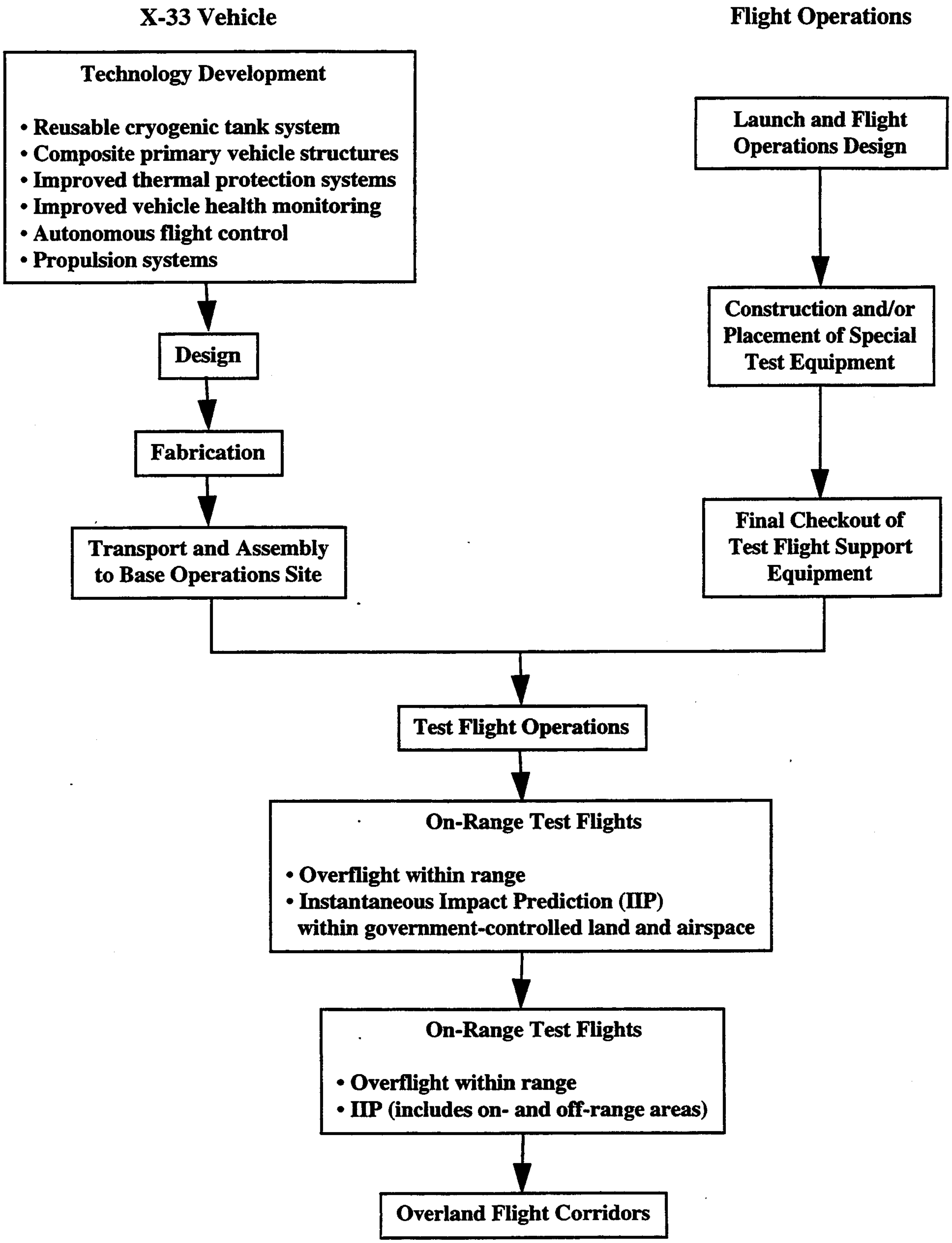


Figure 2.2-1. Elements of the X-33 Advanced Technology Demonstrator Program

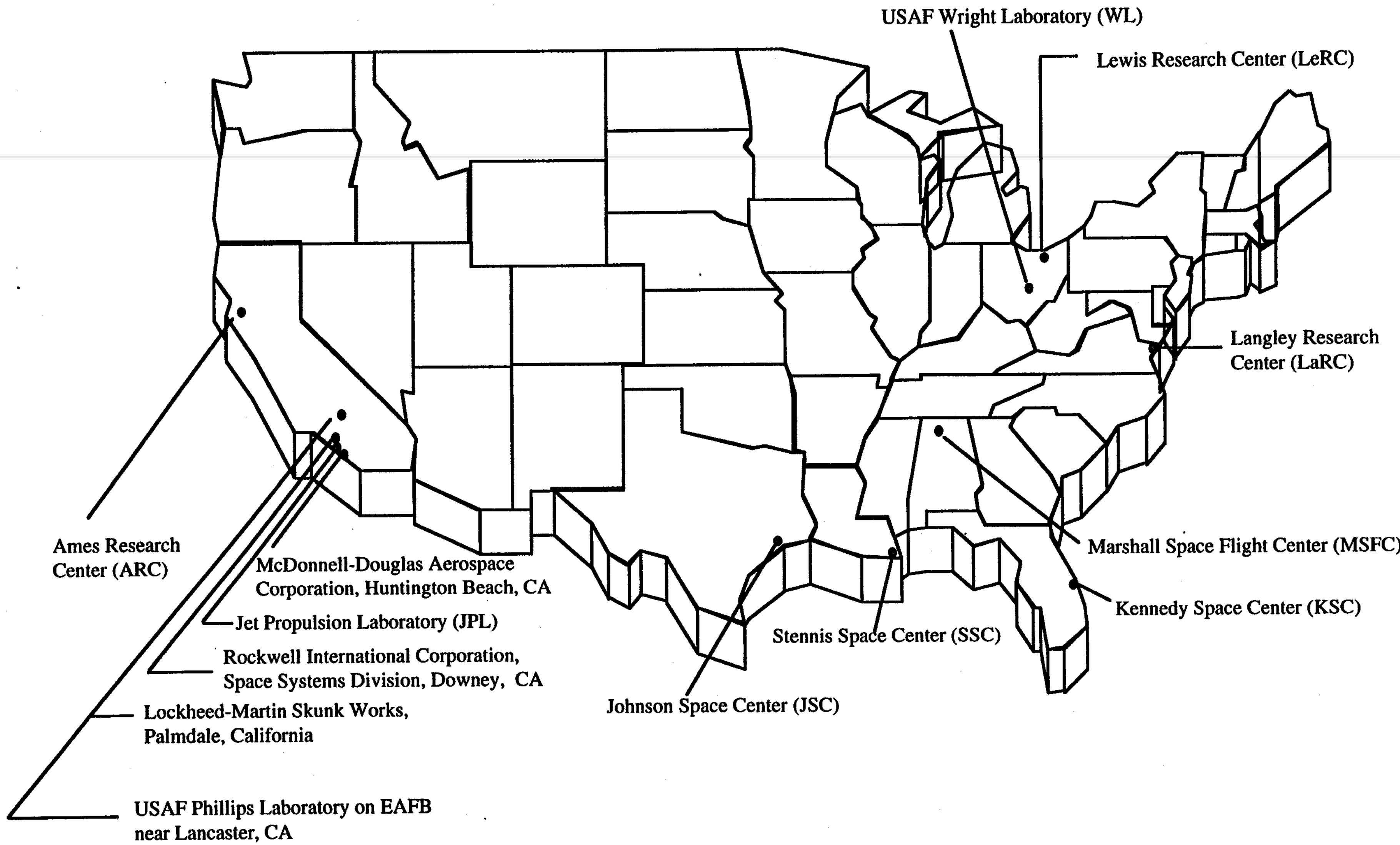


Figure 2.2-2. Potential Major Support Installations

Potential Government installations with specialized equipment, instrumentation, and expertise in the above key technologies include:

- NASA Marshall Space Flight Center, Huntsville, Alabama
- NASA Ames Research Center, Santa Clara County, California
- NASA Lewis Research Center, Cleveland, Ohio
- NASA Langley Research Center, Hampton, Virginia
- NASA Kennedy Space Center, Brevard County, Florida
- NASA Stennis Space Center, Hancock County, Mississippi
- NASA Johnson Space Center, Houston, Texas
- NASA Jet Propulsion Laboratory, Pasadena, California
- USAF Phillips Laboratory on EAFB near Lancaster, California
- USAF Wright Laboratories, Cleveland, Ohio

Basic R&D facilities at the above installations which may be utilized include: wind tunnels; component prototype and/or test article fabrication; materials laboratories; computer laboratories (specialized aerospace hardware and software); component testing; and engine testing (including full propulsion system test capability).

Lead Government program management is the responsibility of:

- NASA Headquarters, Washington, DC
- NASA, Marshall Space Flight Center, Huntsville, Alabama

X-33 R&D activities at the above Government installations are within each installation's mission.

2.2.2 Industry Partner Elements

Major elements of the program anticipated to be conducted at private facilities under ownership or by contract to the Phase II Industry Partner include:

- X-33 spaceplane design, fabrication, and assembly (partial to complete)
- Takeoff support and special operations equipment design, acquisition, and/or fabrication
- Procurement of expendables and raw materials; e.g., fabrication alloys and components, LOX, LH_2, cleaning materials and solvents, hydraulic fluids, etc.
- Program management

One Industry Partner will be selected to conduct Phase II, if a decision to continue is made. One of the following private facilities may be utilized for the Industry Partner elements listed above:

- Lockheed-Martin Skunk Works, Palmdale, California
- McDonnell-Douglas Aerospace Corporation, Huntington Beach, California
- Rockwell International Corporation, Space Systems Division, Downey, California

- Other (CAN 8-3 competition is open to all industries, and award could be made to an Industry Partner not yet identified)

Industry Partner activities at private facilities will primarily use existing processes, manufacturing capabilities, computer assets, and offices. All operate within existing state and federal environmental laws and regulations.

2.2.3 Transport of X-33 From Factory

Transport of the X-33 from the factory, either in complete form or major components for final integration and assembly at the primary operations site, may be by: air (ferry on Shuttle carrier aircraft, Boeing 747, or similar); ground (rail or truck); or water (barge).

2.2.4 Primary Site Operations - Takeoff and Test Flight

Primary site operations include primary support activities for takeoff and test flight. Activities at the primary site represent ultimate integration of all program elements and demonstration of the X-33 spaceplane, activities including preparation for receipt and integration of the spaceplane, takeoff support, and conduct of the test flight program. Major individual elements are:

- Placement of special equipment for takeoff (all three concepts; see Section 2.3.1) and landing (vertical landing only)
- Runway maintenance for horizontal landing
- Propellant storage and handling
- Final spaceplane integration, assembly, checkout, and maintenance
- Component and/or system ground verification and certification tests (laboratory tests, static firings, or propulsion components or systems)
- Cold flow and pressurized tests for leak detection
- Propellant loading
- Flight tracking
- Range Safety (final takeoff commit approval and ultimate abort or flight termination decision authority during flight operations)
- Lifting equipment to secure or remove the X-33 from its transport vehicle
- Data acquisition and management

The test flight program depicted in Figure 2.2-3 for the three spaceplane concepts would be conducted using flight expansion decision criteria. The X-33 would be initially flown entirely within the range's controlled land and airspace. The instaneous impact prediction (IIP), which determines vehicle ground impact area(s) in the event of loss of vehicle either controlled or uncontrolled will also remain within Government controlled land and airspace in the event of a controlled or uncontrolled flight failure. The first flight(s) will be conducted at speeds up to approximately Mach 3 (3600 km/hr or 2250 mph). Mach 1 equals the speed of sound.

The second phase of test flights will be conducted if program management (Government and Industry Partner) and Range Safety are satisfied with the safety and reliability of the spaceplane as demonstrated by X-33 performance and data. The second phase will consist of another series of

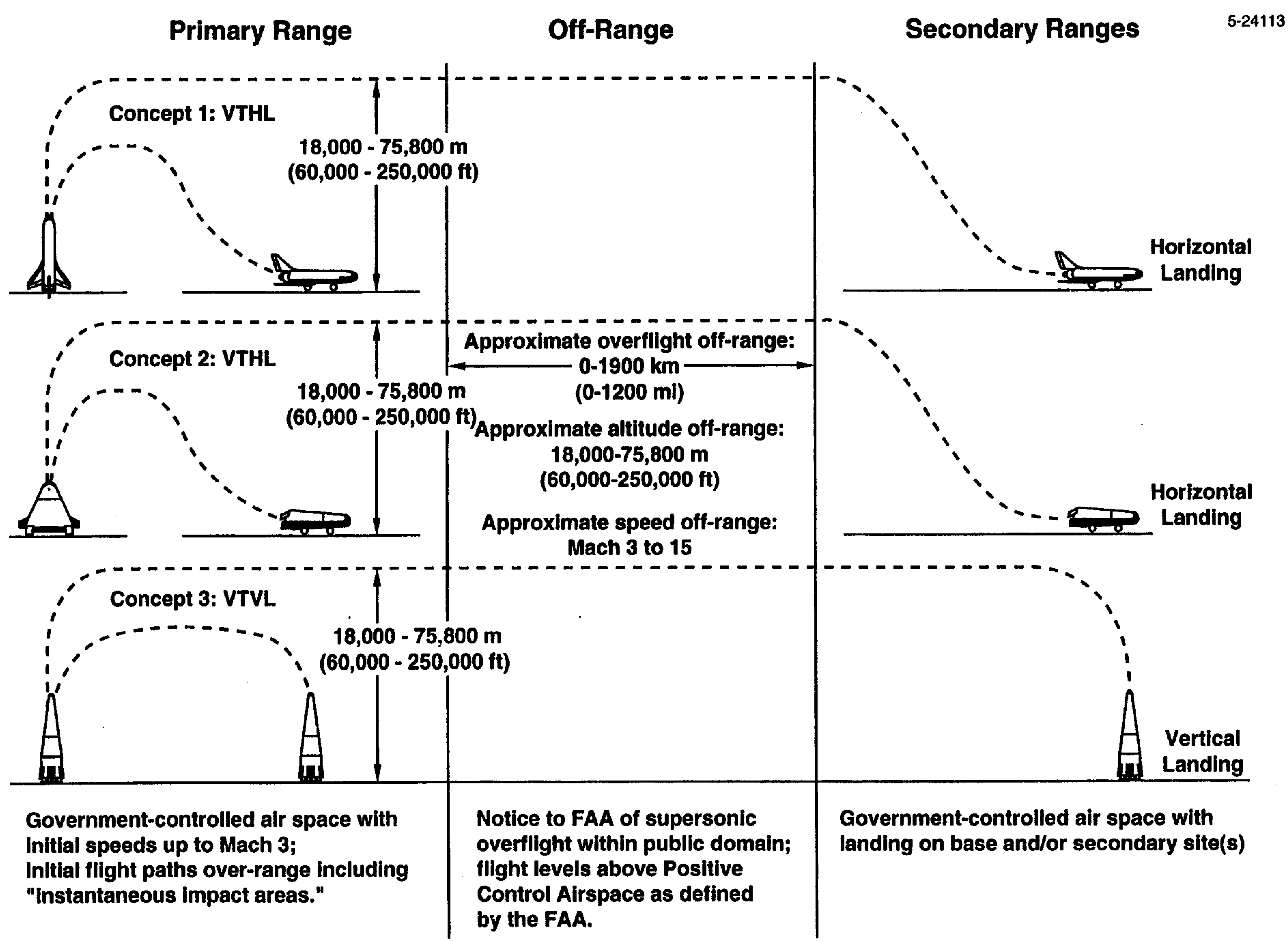


Figure 2.2-3 Concept Flight Test Profiles

flights over the range; however, due to higher speeds anticipated to approach Mach 6, the IIP indicates that instaneous impact areas in the event of vehicle malfunction may be off range. A second comprehensive safety and reliability analysis of the data will be conducted prior to the decision to initiate final test flights off range. Final test flight speeds may approach Mach 15.

Ranges under consideration as reasonable alternatives for primary site operations to be discussed further in Section 3 are:

- EAFB, including NASA DFRC and AFFTC, near Lancaster, California;
- WSMR, including WSTF, near Las Cruces, New Mexico;
- Eastern Range (ER), including KSC and CCAS, on the eastern coast of Florida.

2.2.5 Secondary Landing Sites

Proposed secondary landing site(s) other than those on the primary operations site may be required for landing of the X-33 spaceplane after long range, high Mach speed flights. Only minimal capability will be established at this site(s). This site(s) would be determined following selection of the Phase II Industry Partner. A secondary landing site, if needed, must have the following capabilities (existing or augmented by the X-33 Program):

- Runway for horizontal landing (existing only);
- Landing site for vertical landing with sufficient surrounding zone to accommodate fire protection, noise, and explosive safety requirements;
- Tracking and control center (minimal mobile ground support equipment anticipated); and
- Return to primary site support equipment.

2.2.6 Off-Site Test Flight Corridors

Proposed off-site test flight corridors, preferences and alternatives, would be determined following selection of the Phase II Industry Partner. Test flight corridors for the two western ranges may include several states. ER test flight corridors would be primarily over water; however, states with a secondary landing site(s) may include one or more Government installations along the eastern coast of the U.S. or on islands to the east or south of the ER.

2.2.7 Transport of X-33 From Secondary Landing Site(s)

Transport of the X-33 from a secondary landing site, either in complete form or major components may be accomplished by: air (ferry on Shuttle carrier aircraft, Boeing 747, or similar); ground (rail or truck); water (barge), and flight.

2.3 Alternatives

2.3.1 X-33 Spaceplane Concepts

The X-33 spaceplane concepts are characterized by:

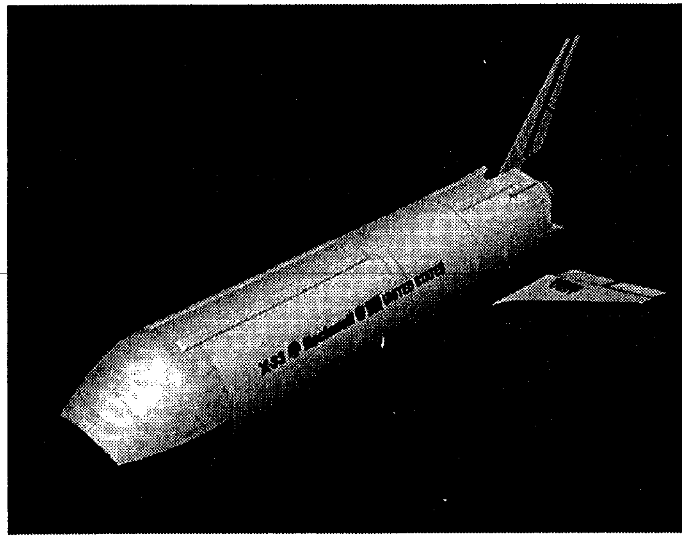
- Operations driven design with adequate margins
- Highly maintainable with ease of access to components
- Highly reliable subsystems
- Lightweight composite structures
- Reusable composite and metal cryogenic propellant tanks
- Durable TPS
- High performance, high reliability rocket engines
- Automated avionics and health management subsystems

The three spaceplane concepts under consideration for Phase II are shown in Figure 2.3-1. Concept 1 is a VTHL, wing body design. Concept 2 is a VTHL, lifting body design. Concept 3 is a vertical takeoff/vertical landing (VTVL) design or a third generation DC-X.

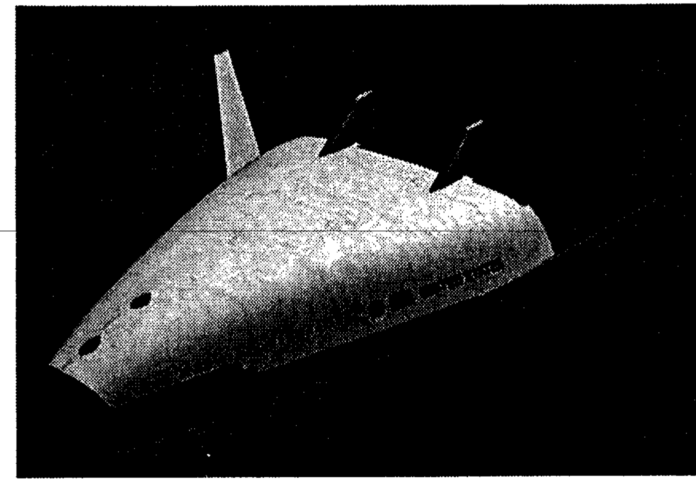
To provide an approximate size scale for the three concepts, they are shown in comparison to common commercial aircraft in Figure 2.3-2. The concepts are described collectively from information compiled by Austin and Cook in order to protect company proprietary information. Portions of the following text distinguished by quotation marks contain direct text from the article prepared by Austin and Cook, "SSTO rockets: Streamlining access to space." (1994)

Concepts under development for the X-33 Program and ultimately for design of a commercially viable SSTO share common design philosophies and goals which provide the basis for the following common descriptive details of the ultimate X-33 Advanced Technology Demonstrator spaceplane to be designed, fabricated, and test flown as part of the RLV Technology Program. The final design will integrate lessons learned from the Space Shuttle with aircraft programs. "In order to enhance reliability, maintainability, and supportability, a fully reusable single-stage-to-orbit spaceplane must have:

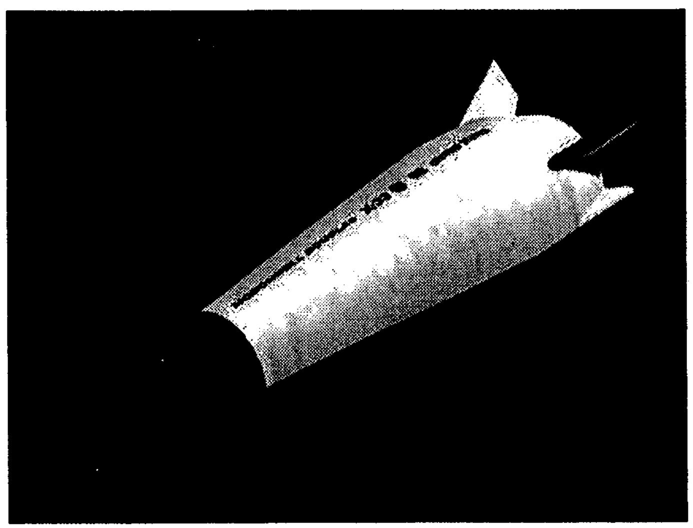
- One-time spaceplane flight certification
- Single-engine-out capability throughout ascent (either return to site or abort to orbit/once-around)
- Durable TPS
- Robust, operable main engine system
- Robust, accessible subsystems
- Autonomous flight control (humans as passengers, not flight crew, except in some on-orbit cases)



Concept 1



Concept 2



Concept 3

Figure 2.3-1. X-33 Spaceplane Concepts

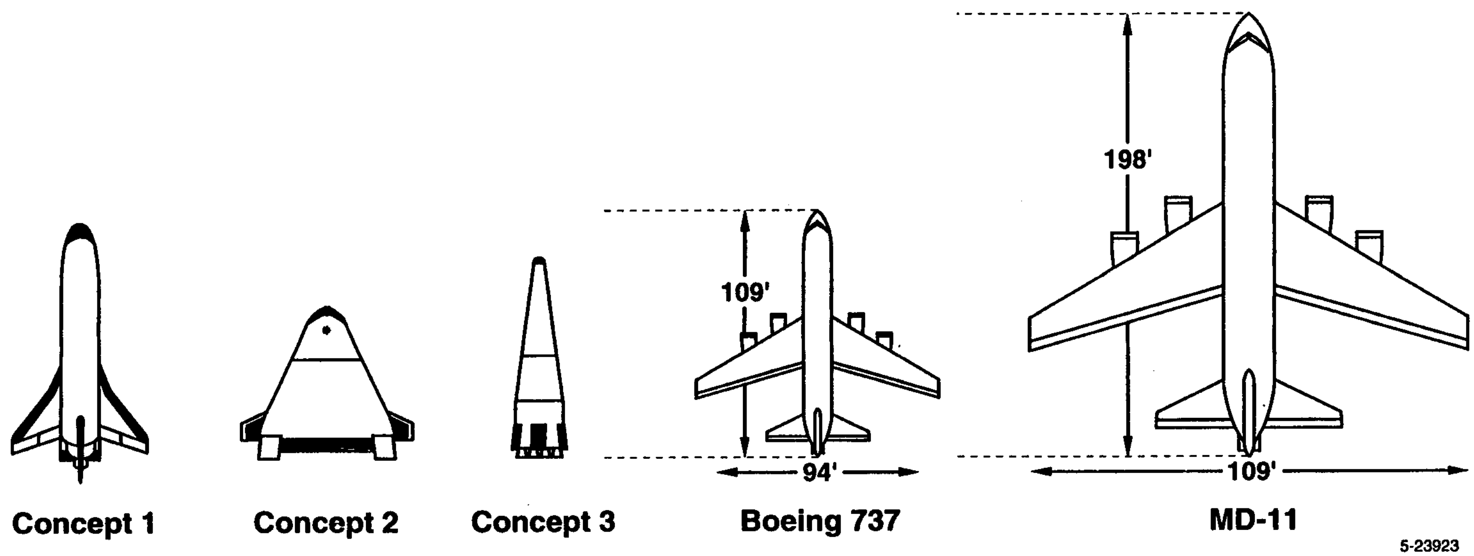


Figure 2.3-2. Comparison of X-33 Spaceplane Concepts with Commercial Aircraft

Additional design requirements include:

- Eliminating down-range abort sites
- Eliminating distributed hydraulics
- Eliminating hypergolic propellants (highly toxic propellants which spontaneously ignite upon mixing and must be carefully managed)
- Processing payloads off-line
- Minimizing serial processing
- Incorporating a standardized payload canister with common interfaces for off-line payload processing and rapid integration."

Distinguishing features of the three concepts are provided in Table 2.3-1.

Table 2.3-1. Distinguishing Features of the Three X-33 Spaceplane Concepts

Concept	Ascent/Descent Mode	Distinguishing Feature(s)
1	VTHL	Wing body; circular cross-section fuselage for structural efficiency; single vertical rudder/stabilizer for yaw control; payload bay between an aft LH_2 tank and a forward LOX tank.
2	VTHL	Lifting body; payload bay between two outboard LH_2 tanks placed within an aeroshell; linear aerospike main engine.
3	VTVL	Reenters nose first and performs a rotation maneuver with main engine reignition before landing; payload bay located in a transverse orientation between the LOX and LH_2 tanks.

To reduce weight, fatigue, and corrosion, nonpressurized primary structures will be made of graphite composite. TPS candidates for the "acreage" areas or large external surface areas include ceramics similar to those used on the Space Shuttle's Orbiter today and metallic materials such as multiwall, sandwich panel, and honeycomb. "Leading edge, nose cone, and control surface material candidates include advanced carbon/carbon and ceramic matrix composites."

The X-33 must incorporate and successfully demonstrate reusable cryogenic propellant tanks for very cold LOX and LH_2 propellants. No spacecraft to date has accommodated this feature. The ET, which holds LOX and LH_2 on the Space Shuttle at launch, is jettisoned just prior to orbital insertion of the Orbiter and burns up in the atmosphere upon reentry. Tank materials under consideration are Al-Li alloys and graphite composite.

LOX/LH_2 engine(s) are planned for all three concepts with no consideration of the alternate propellant systems such as LOX/RP-1 (rocket propellant #1, a term for a highly refined kerosene product) and LOX/LH_2/RP-1. LOX/LH_2 engines produce water as the main product of combustion and are considered the most environmentally benign of all engine propellant alternatives.

The X-33 spaceplane must demonstrate potential for significantly cheaper operations. Reliability, maintainability, and supportability requirements must be incorporated early in the spaceplane design to achieve significant operational cost savings. Any new spaceplane system must address three basic issues to produce these reductions:

1. **Transportation mission:** The primary focus is on unmanned, cargo transportation. The SSTO system will not have the same capabilities as the Space Shuttle, which serves as a transportation system and space platform. The space station will be the platform, while the SSTO system will transport personnel and cargo to and from the station in addition to its other non-station missions. Astronauts will be passengers, not pilots. (Hence the need to flight test in a remotely piloted mode. In addition, the SSTO system will be used for other non-space station missions.)

2. **Spaceplane simplicity:** The single-stage, fully reusable design concept stresses simplicity and reduced operating costs by eliminating the need for multistage assembly and verification. Continuous manufacturing to replace expendable hardware will not be needed. Avoiding toxic hypergols for attitude control and distributed hydraulic systems will simplify spaceplane turnaround requirements. Eliminating processing and integration of multiple elements (some extremely hazardous) will reduce turnaround times, facility requirements, and labor. Vehicle health management/monitoring, now used on the Shuttle and commercial and military aircraft, will enable automatic system health identification during and after flight. Vehicle health monitoring refers to the system of monitoring devices for critical parameters such as pressure and temperature at various points, stability, fuel volume, etc.

3. **Fleet certification:** Certification will be accomplished through an extensive two-to-three year ground test and flight test program (i.e., the X-33 Program). This program (X-33) will demonstrate and validate flight spaceplane design and operational capabilities using a demonstrator spaceplane approximately one-half the size of an RLV.

2.3.2 Propulsion System: LOX/LH_2

The engine technology being considered for the X-33 spaceplane is based on existing LOX/LH_2 propellant technology, the most environmentally benign of rocket propellants, producing only water as the main product of combustion. Final selection of the engine(s) has not been made.

2.3.3 Takeoff Control and Support Operations (Primary Sites)

Locations of the three reasonable primary site alternatives for takeoff and test flight operations are shown in Figure 2.3-3.

2.3.3.1 EAFB/AFFTC/DFRC

EAFB (Figure 2.3-4) is a major Department of Defense (DOD) USAF Range Test Facility comprising over 122,000 hectares (ha) (301,000 acres (ac)) in southern California's Antelope

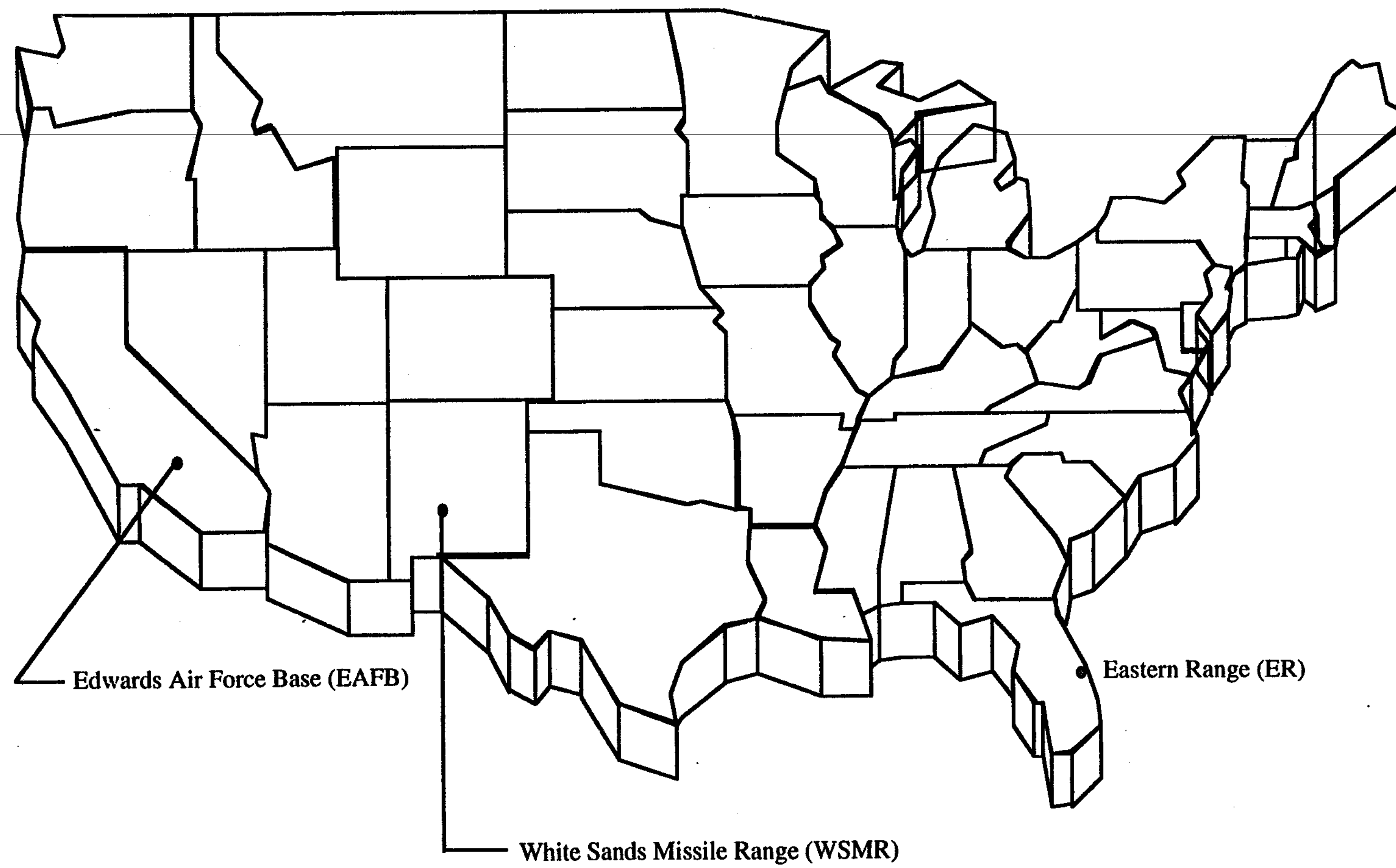


Figure 2.3-3. Locations of Three Takeoff Site Alternatives

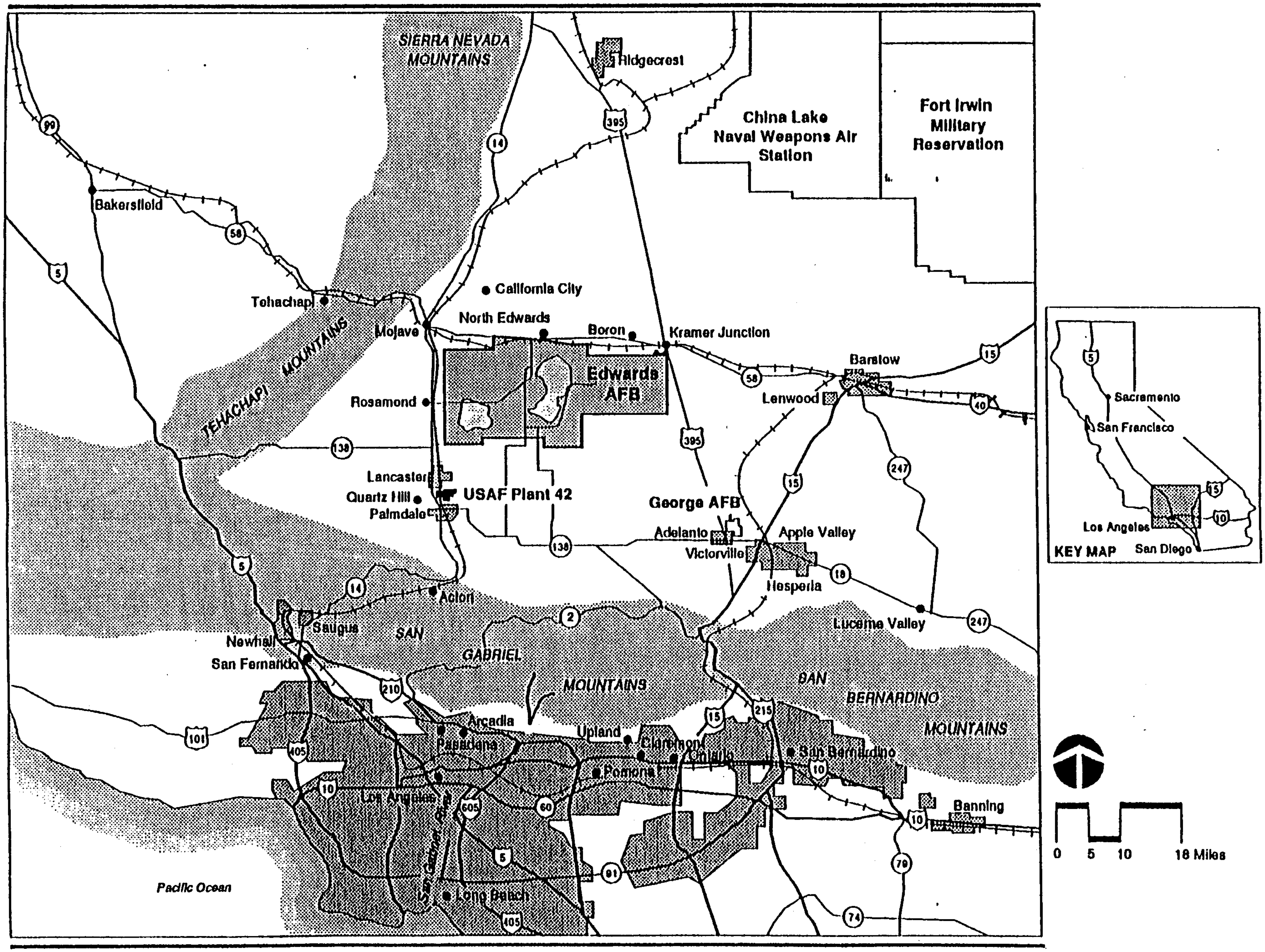


Figure 2.3-4. Edwards Air Force Base

Valley in the western part of the Mojave Desert. EAFB currently hosts the Air Force 412th Test Wing, which operates the AFFTC and performs testing and evaluation of aerospace vehicles, including research aircraft, remotely piloted vehicles and drones, and full-scale engineering aircraft. The 412th Test Wing provides engineering expertise to develop, test, and evaluate operational capabilities of aircraft and aeronautical weapon systems for use by the USAF. The Test Wing provides technical capability to ensure compatibility of facilities, instrumentation, test techniques, and analytical methods to support test and evaluation programs. EAFB is the primary western U.S. landing site for Space Shuttle flights. (EAFB 1994-A)

AFFTC is tasked to support the Air Force Materiel Command (AFMC) by conducting and supporting testing of both manned and unmanned aerospace vehicles. The mission involves not only all aspects of testing air vehicles, but includes flight evaluation and recovery of research vehicles, development testing of aerodynamic decelerators, and operation of the Air Force Test Pilot School. AFFTC is best known for X-series experimental aircraft tests and Space Shuttle recovery. However, the majority of the workload consists of testing total weapons systems, including major subsystems, as a part of cradle-to-grave AFMC systems development and support. AFFTC also has an array of ground test facilities, including the West Base Complex, for complete testing of fully integrated avionics in a simulated flight environment. A complete Class II modification capability exists to design, manufacture, and install instrumentation and make other changes to the test article as required for the test program. Ground vibration, storeweight, and moment facilities are available for structures testing, as well as special data analysis equipment for loads and flutter tests. (EAFB Undated)

DFRC is a tenant organization on EAFB. It comprises 340 ha (830 ac) on the shore of Rogers Dry Lakebed. DFRC is an aeronautical research facility developing new technologies to improve aircraft flight control components and systems and to transfer new concepts to the U.S. aerospace industry for commercial and military applications. In general, DFRC maintains its own infrastructure while reimbursing EAFB for utilities. (DFRC 1996)

PL is an EAFB tenant located on Leuhman Ridge east of Rogers Dry Lake. Facilities on Leuhman Ridge have been used for test firings of rockets and engines for a number of years. The USAF recently announced a plan to consolidate the nationwide PL facilities at Kirtland AFB, New Mexico. The plan will only move a portion of PL; the test stands will remain under PL's authority. The engine test stands on Leuhman Ridge will remain and can be used for this alternative regardless of whether PL is the organization operating the facility. (EAFB 1992)

USAF Plant 42 (Figure 2.3-5) is an existing, Government-Owned/Contractor-Operated (GOCO) facility in Palmdale, California, approximately 48 km (30 mi) south of EAFB. It comprises approximately 2,071 ha (5,117 ac) of land mass. There are several civilian contractors at AF Plant 42, predominantly Lockheed-Martin, Northrop Grumman, and Rockwell. Lockheed-Martin and Rockwell have other facilities adjacent to the southern border of the plant. AF Plant 42 has a history of constructing test aircraft, performing final assembly, and supporting flight tests for aircraft and aerospace vehicles, including the SR-71 Blackbird, F-111 fighter, B-1 and B-2 bombers, and Space Shuttle. The majority of the plant is devoted to airfield, industrial, and vacant land use categories, with smaller areas of administrative and aviation/test program support. The central portion is dominated by Runways 07/25 and 04/22, which generally trend east/west. A 150 m

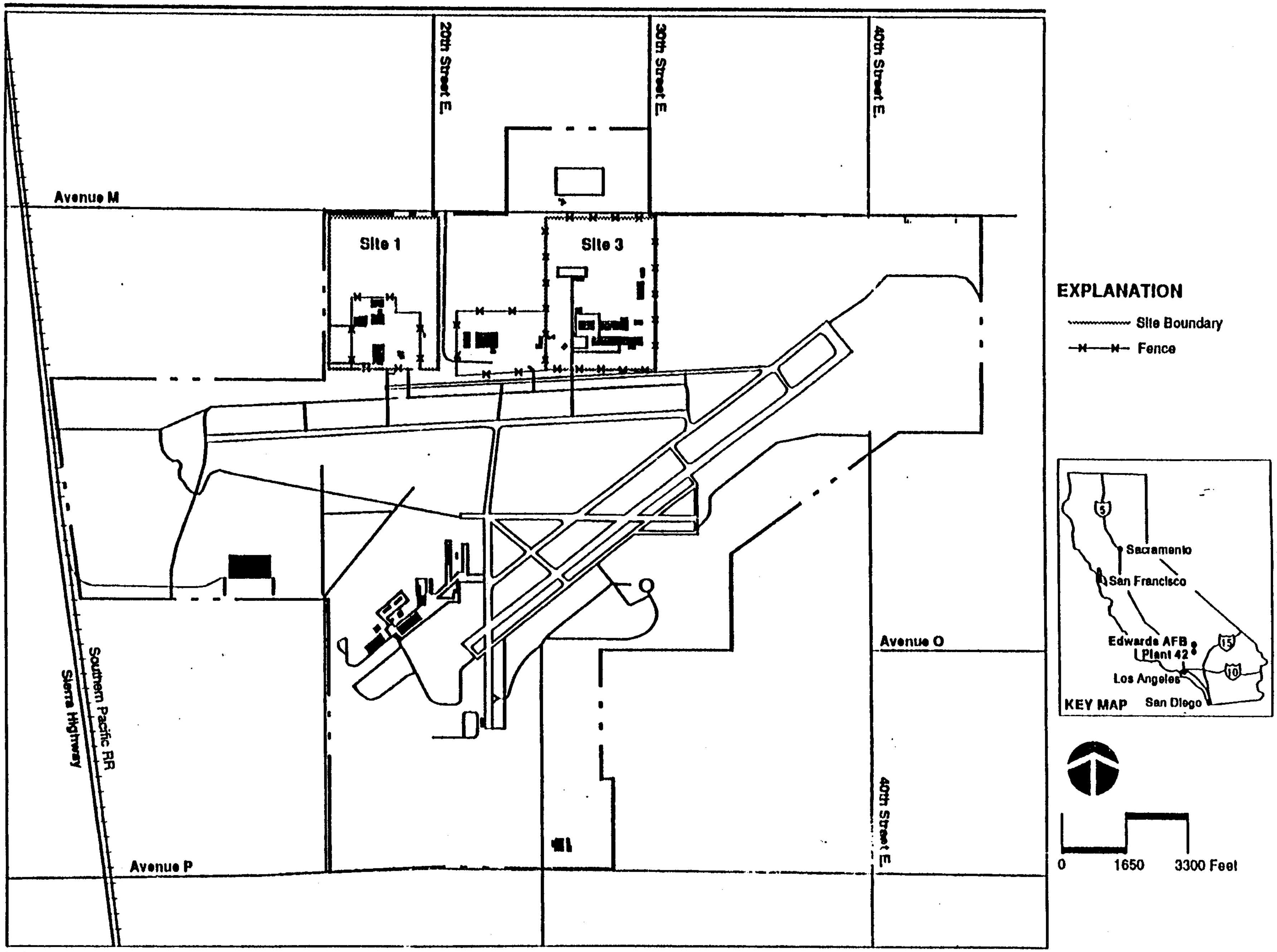


Figure 2.3-5. U.S. Air Force Plant 42

(500 ft) wide buffer zone conforms to the plant's exterior property line and establishes a security buffer for plant activities. (EAFB 1992)

Four takeoff and landing sites are being considered for the X-33 Program at EAFB: South Base Site, Space Port 2000 Site-1, Space Port 2000 Site-2, and NASA-North Base Site are shown in Figure 2.3-6.

South Base Site

The proposed X-33 South Base site is located at the original site of flight operations at EAFB. The B-2 bomber hangar and office buildings are located in this area, and it is from this location that B-2 flight operations are conducted. The proposed site is located at the end of an abandoned runway that branches off diagonally from South Base runway 6/24 as shown in Figure 2.3-7. The proposed takeoff stand is approximately 1.8 km (1.1 mi) from the B-2 facility. The landing pad for a VTVL X-33 would be located to the northeast. One option would be to place the X-33 in the B-2 hangar between flights and tow it on a multi-tire dolly or its landing gear to and from the takeoff stand and hangar via the abandoned runway. The proposed site is also located approximately 1.34 km (0.83 mi) from Building 730, a munitions integration test facility, which could be evacuated prior to takeoff if required. Midway between Building 730 and the South Base Site are the South Base Munitions Area storage bunkers. Use of these bunkers for munitions storage is being phased out, and by the first flight of the X-33 all munitions will have been removed from the area. Water, power, and communications lines, including fiberoptic cables, extend to Building 730. This is the point from which utility extensions would be extended to the proposed site.

Space Port 2000 Site-1

Space Port 2000 Site-1 is located southwest of the South Base area on the edge of Rogers Dry Lake. The X-33 takeoff stand would be located approximately 5 km (3 mi) from the B-2 facility and approximately 3 km (2 mi) from Building 730. The site option provides additional separation distance from existing facilities, if required, based on explosive safety/quantity-distance (ES/QD), takeoff noise, and debris pattern analyses. The VTVL landing pad would be located northeast of the takeoff stand. A tow route on paved two-lane roads is available from the B-2 hangar to the proposed site. From Building 730, the first 2.6 km (1.6 mi) of roadway would require repaving and the final 0.5 km (0.3 mi) of roadway would require new construction. Water, power, and communications would be extended 3.1 km (1.9 mi) to the site from Building 730.

Space Port 2000 Site-2

Space Port 2000 Site-2 is located northwest of Space Port 2000 Site-1 as shown in Figure 2.3-7. This site is located further east from Space Port 2000 Site-1, providing a wider takeoff azimuth (trajectory or path) and vertical landing approach azimuth capability, but reducing separation distances from existing facilities. An existing paved road running through the site would provide a tow route from the B-2 hangar. Utilities would be extended 2.1 km (1.3 mi) to the site from Building 730.

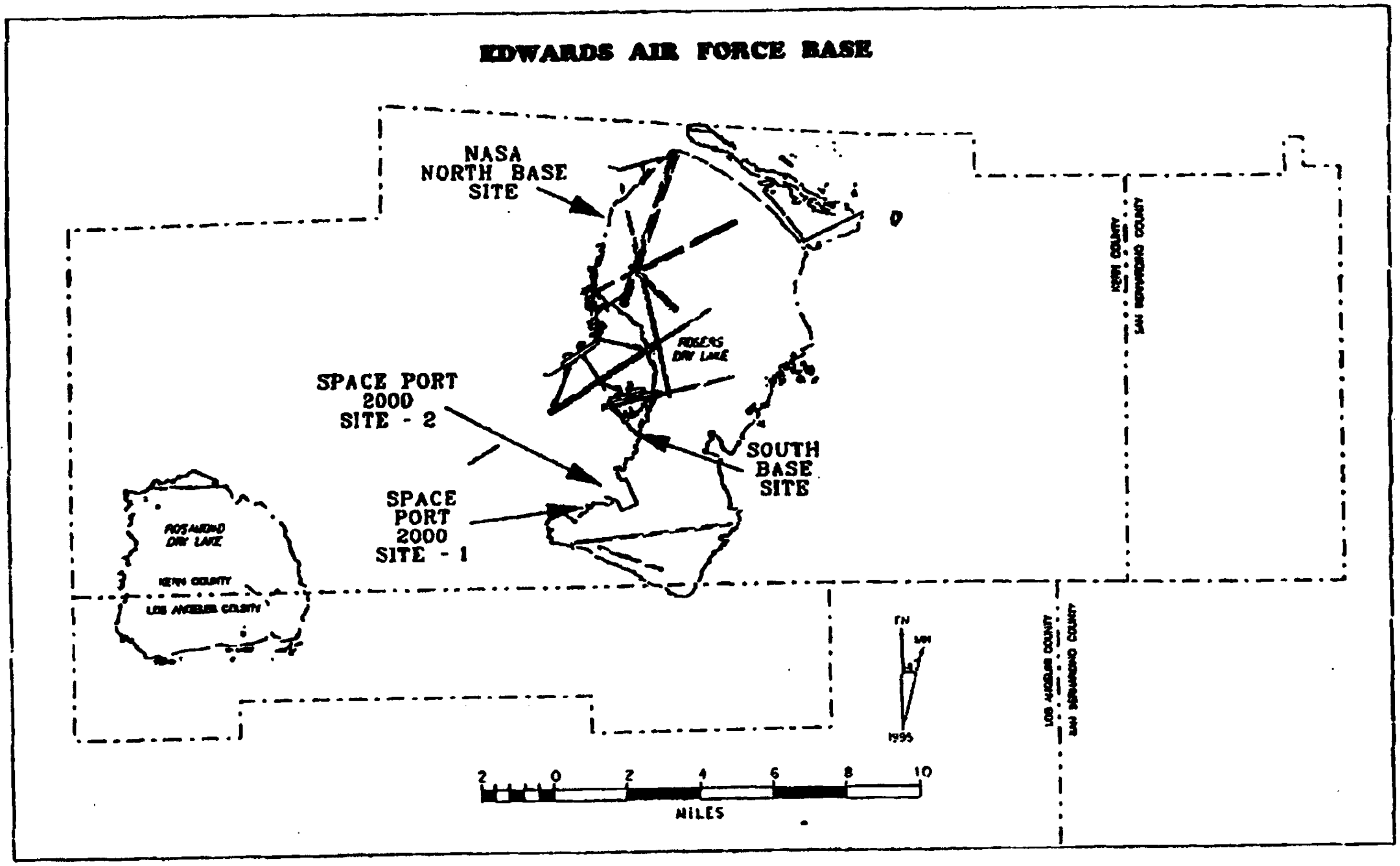


Figure 2.3-6. Proposed Takeoff Sites on EAFB

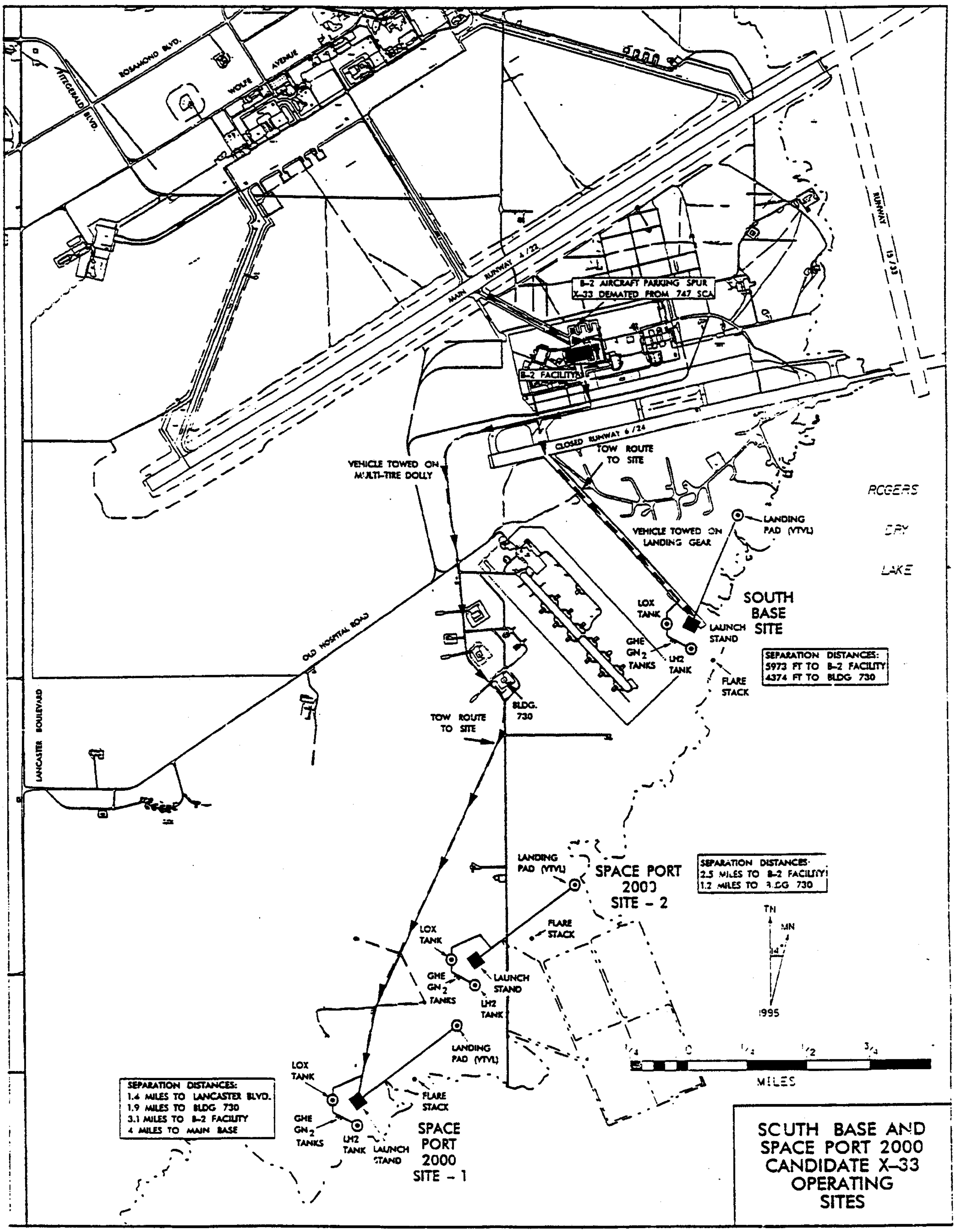


Figure 2.3-7. Proposed Takeoff and Landing Sites on EAFB South Base

NASA-North Base Site

The NASA-North Base site is located north of DFRC and south of the Edwards North Base facility at an abandoned jet engine test facility. The facility was used by General Electric Corporation for open-air testing of engines on B-2 and F-22 aircraft. The proposed site location is shown in Figure 2.3-8 and is approximately 1.3 km (0.8 mi) from the Space Shuttle Mate/Demate Device (MDD), approximately 1.3 km (0.8 mi) from the Space Shuttle hangar, and approximately 1.8 km (1.1 mi) from the DFRC Integrated Test Facility (ITF). The proposed site provides easy access to existing Space Shuttle related facilities at DFRC. A paved road connects to DFRC from which a taxiway provides a tow route from the Edwards Main Base runway to the site. Water, power, and communications are also available.

2.3.3.2 WSMR/WSTF

WSMR (Figure 2.3-9) is a major DOD range and test facility located near Las Cruces, New Mexico. The range possesses unique characteristics necessary for the U.S. Army, USAF, U.S. Navy (USN), NASA and other federal and commercial testing concerns to conduct safe, large-scale experiments on advanced weapons and space flight systems. WSMR covers approximately 828,800 ha (2,048,000 ac) in south central New Mexico and is the largest overland test range in the Western Hemisphere. The primary mission of WSMR is operation of a National Range in accordance with direction from the U.S. Army Test and Evaluation Command (TECOM). The mission includes: conduct of range instrumentation research and development; development tests of air-to-air, air-to-surface, surface-to-air, and surface-to-surface missile systems; dispenser and bomb drop programs; gun system testing; target systems; meteorological and upper atmospheric probes; equipment, component. and subsystem programs; high-energy laser programs; and special tasks. (WSMR 1996-A)

The main launch complexes encompass approximately 240 ha (600 ac) north of Nike Avenue and east of the Main Post. It contains eight active launch complexes (LC-32 to LC-38 and LC-50). They support ground-to-ground and ground-to-air missile launches and the Navy Gun Program. Six additional launch complexes have been set aside for future development. (WSMR 1996-A)

WSTF (Figure 2.3-10) is a NASA facility located on 24,605 ha (60,800 ac) along the western flank of the San Andreas Mountains in southwestern New Mexico. It is situated in an isolated area on WSMR to limit effects of the inherent test hazards of the installation on the surrounding population. The site comprises an industrial area and a surrounding buffer zone. Placement of special test equipment in the buffer zone requires prior approval from the WSMR Master Planning Board and the Commanding Officer; however, WSTF may make modifications to the industrial area without WSMR's approval. WSTF provides expertise and infrastructure to test and evaluate spacecraft materials, components, and propulsion systems. (WSMR 1994)

The two proposed WSMR takeoff sites for the X-33 are the WSMR LC-39 launch complex on Nike Avenue and an area near the existing test site used for the DC-X and Clipper Graham Programs at White Sands Space Harbor (WSSH).

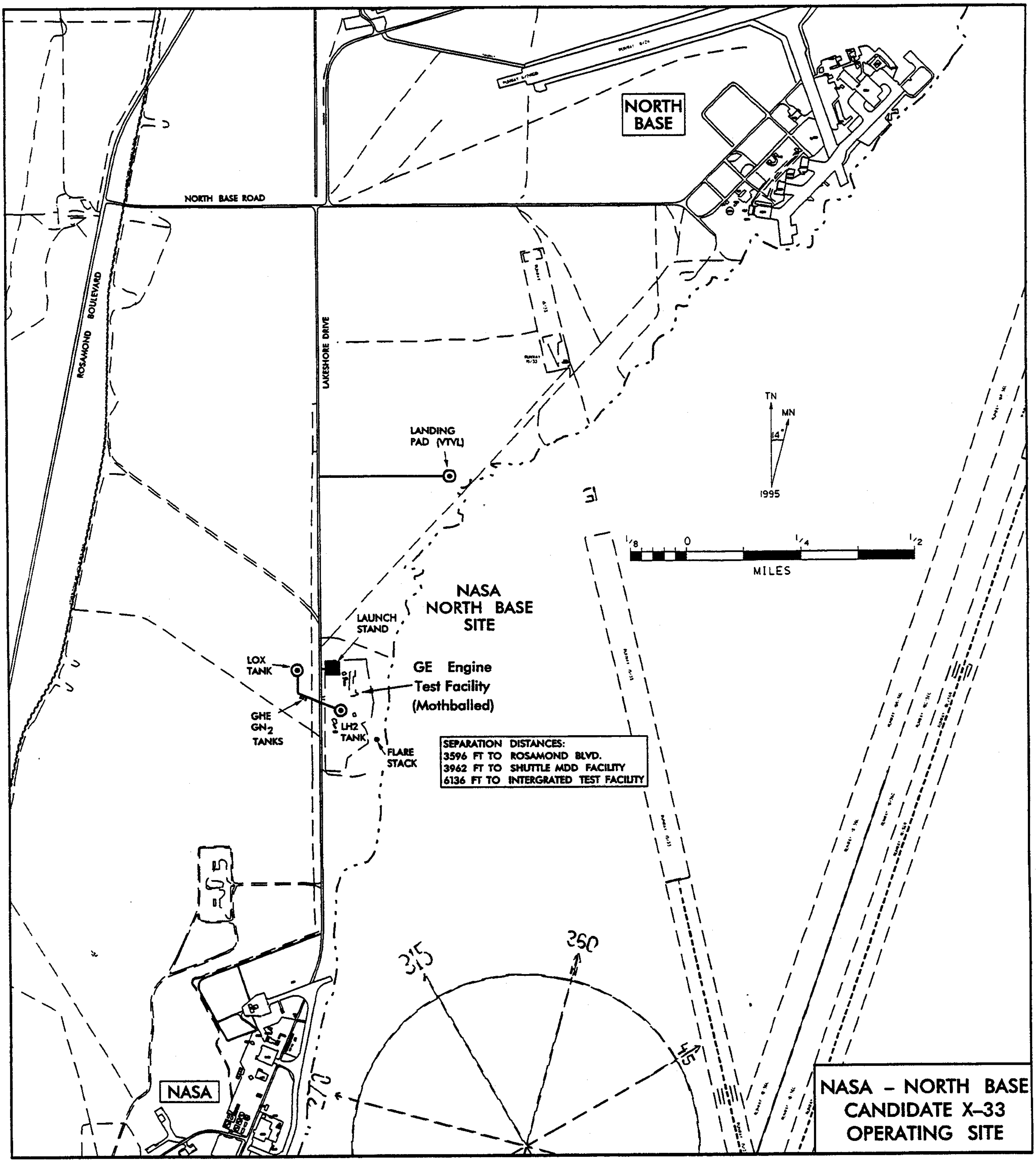


Figure 2.3-8. Proposed Takeoff and Landing Site on EAFB North Base

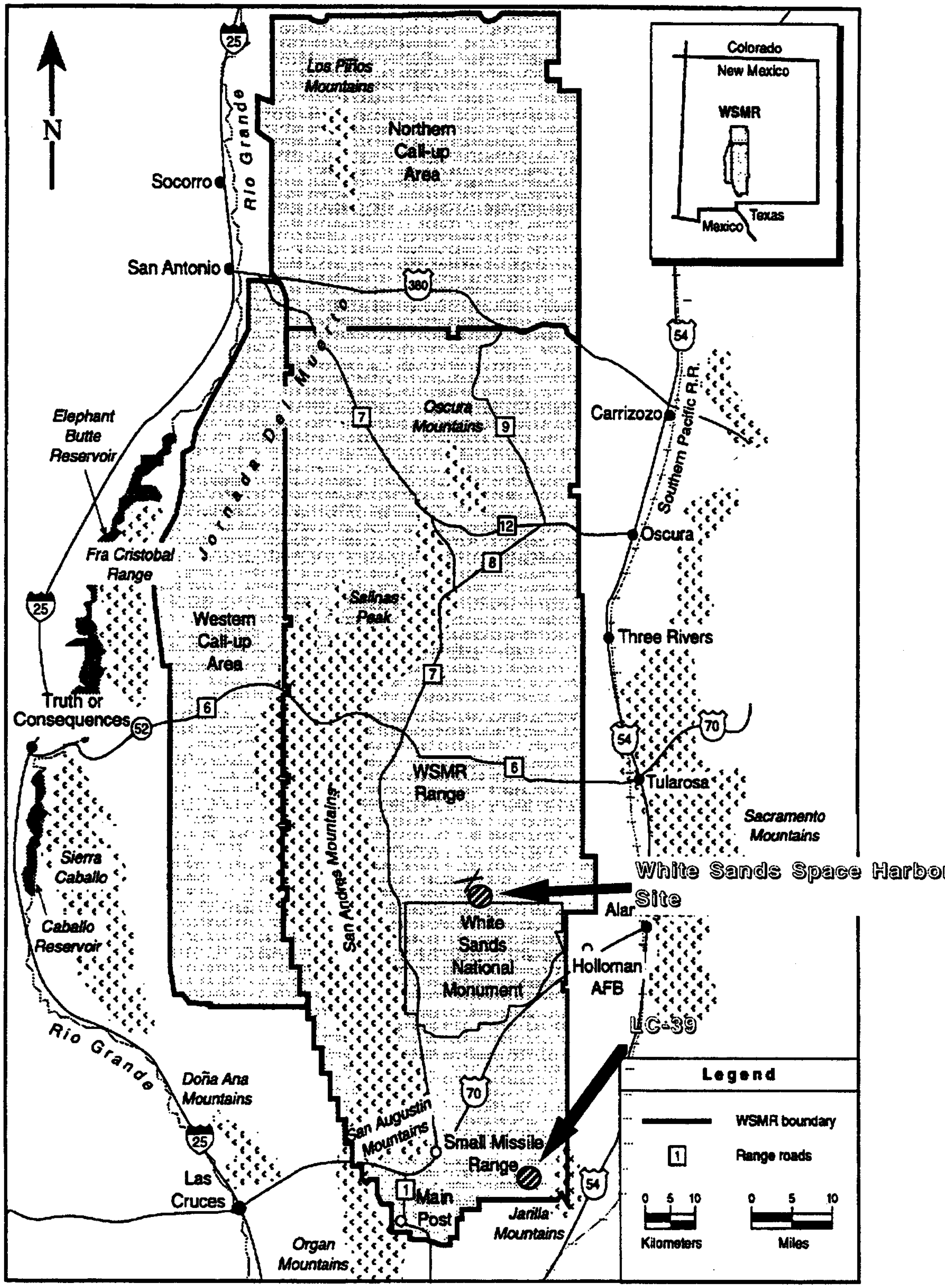


Figure 2.3-9. White Sands Missile Range

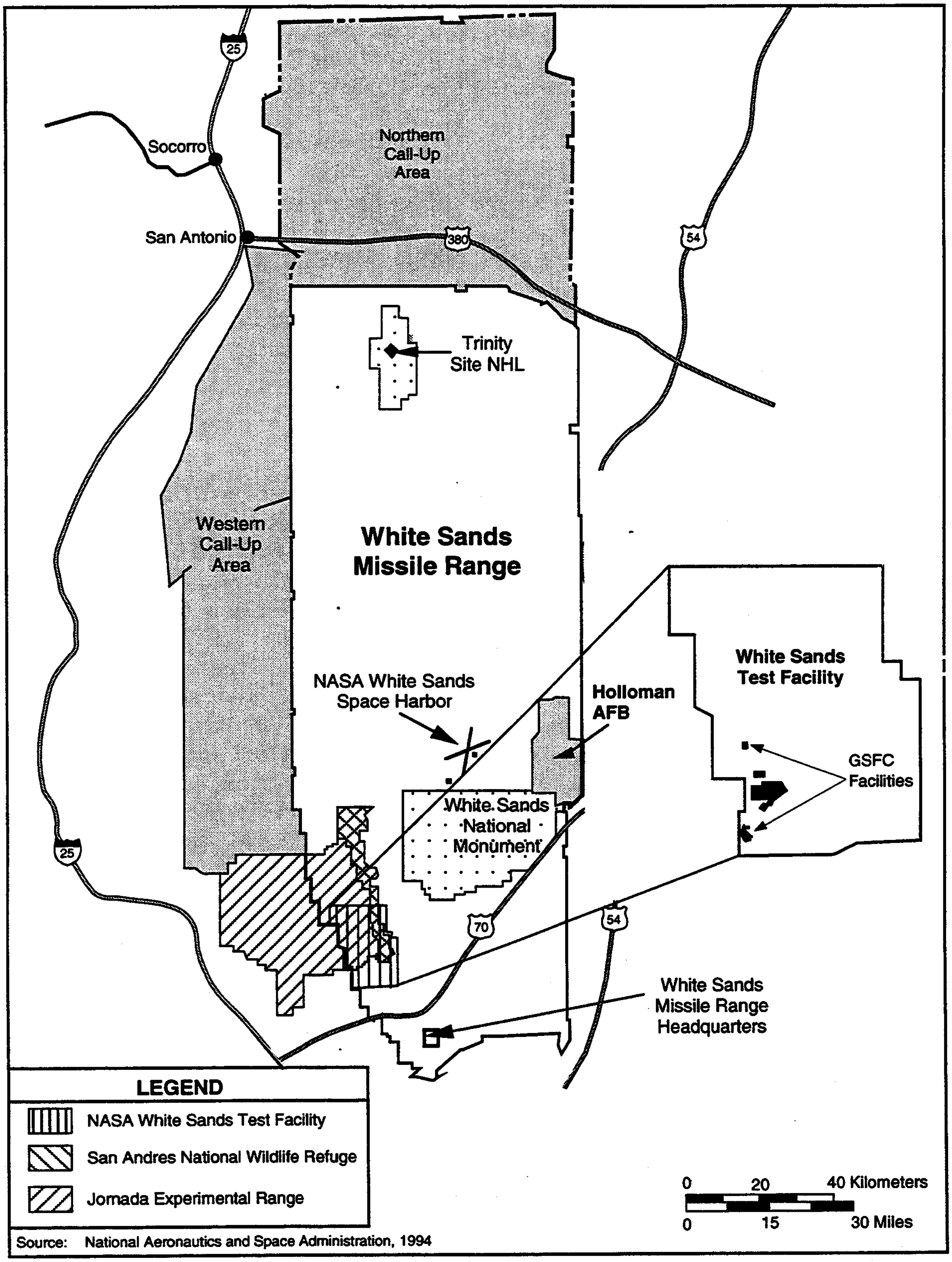


Figure 2.3-10. White Sands Test Facility

WSMR Launch Complex 39

The WSMR LC-39 site is a cleared area used for launching missiles off mobile launch equipment. It is part of the Nike Avenue launch complexes. The only facility on the site is a berm. Power and a liquid petroleum gas tank are available at the site. (WSMR 1996-B)

WSSH

WSSH is an airfield and operations complex built on a dry gypsum lakebed near the Columbia site used for DC-X and Clipper Graham testing. The airfield is used by the Army as a recovery landing site for battle-damaged drone aircraft. NASA uses WSSH for Space Shuttle pilot training and as an alternate Space Shuttle landing site. It is located north of U.S. Highway 70 within WSMR boundaries, about 88 km (55 mi) northeast of WSTF and about 4 km (2.5 mi) east of the San Andreas Mountains. (WSMR 1994). It is near existing roads, power, and communication systems. (WSMR 1996-A)

2.3.3.3 ER

The ER (Figure 2.3-11) consists of the USAF's CCAS, Patrick Air Force Base (PAFB), several downrange tracking stations, and NASA KSC. The USAF 45th Space Wing (45 SW) manages the ER, which extends over 16,000 km (10,000 mi) from the Florida mainland through the South Atlantic into the Indian Ocean. One of the tracking stations, Antigua Air Station, is 2,000 km (1,250 mi) south of CCAS, while Ascension Auxiliary Air Field is nearly 8,000 km (5,000 mi) downrange. Users of the range include: USAF, U.S. Army, USN, NASA, foreign governments, European Space Agency, and various private industry space launch contractors. NASA's Space Shuttle Program, USN's Trident II submarine-launched ballistic missile, and private industry space launch contractors are all supported by the ER. During launch, ER customers rely on 45 SW personnel for tracking, communications, optics, weather forecast, and telemetry, all of which provide critical flight data. The central computer complex processes information and passes data to launch agency personnel, 45 SW Range Safety directorate, and 45th Weather Squadron. The 45 SW also processes and launches DOD satellites on Delta II, Atlas II, and Titan IV expendable launch vehicles. (USAF 1996)

CCAS is located on 6,900 ha (17,200 ac) on a barrier island on the east coast of Central Florida. It was selected in 1947 as the site for a United States Missile Testing Range. Throughout its history, CCAS has been instrumental in establishing of numerous guided missile weapons systems, the Man in Space Program, and various DOD and commercial satellite programs. The first missile, a German V-2 rocket with an Army WAC Corporal second stage, was launched July 24, 1950. During the next 3 years, facilities were constructed for testing of Matador, Snark, and Bomarc missiles. The first launch of the Saturn I space vehicle took place in 1961. In 1962 CCAS was selected to support the Titan III Program, with its first launch in 1965. Other programs conducted at CCAS include: Jupiter-C, Thor, USN Polaris, and USAF Atlas ballistic programs; and Pershing, Delta, Poseidon, Minuteman, and Trident programs. CCAS is currently lead range for SDIO in-orbit testing. A total of 36 launch complexes exist; seven of which are currently active. CCAS is located in Brevard County, approximately 250 km (155 mi) south of Jacksonville and 300 km (210 mi) north of Miami. The station is bordered on the east by the Atlantic Ocean, on the west by the

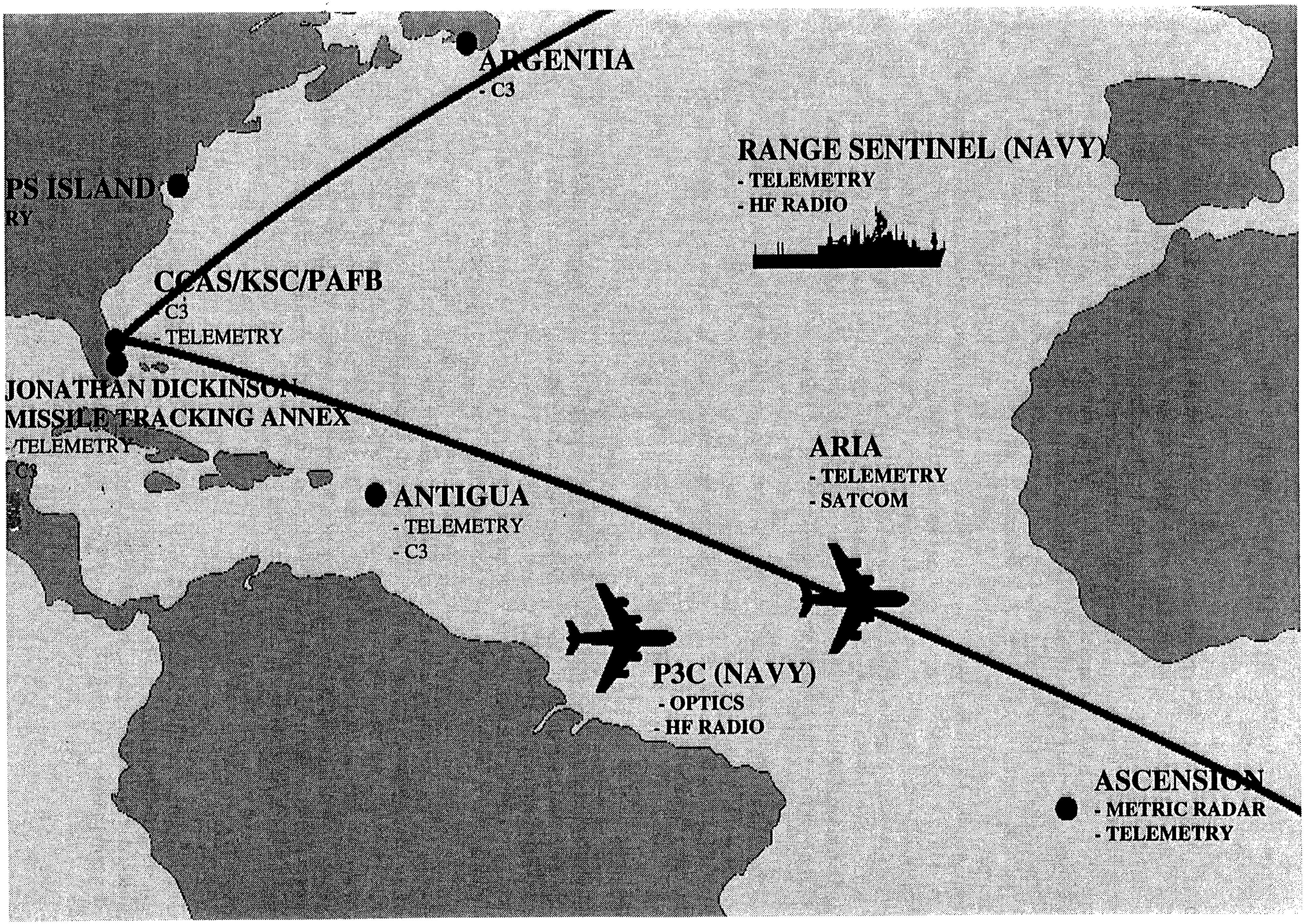


Figure 2.3-11. Eastern Range

Banana River, on the south by Port Canaveral, and on the north by KSC. (CCAS 1994-C, CCAS 1994-D, USAF 1996)

KSC (Figure 2.3-12) owns approximately 56,500 ha (140,000 ac) of land and water property and maintains operational control over approximately 2,600 ha (6,500 ac). As the principal site for launches of NASA space systems, KSC processes, launches, and lands the Space Shuttle and its payloads, and is preparing to support the International Space Station. Two active launch pads are located on KSC. KSC's responsibilities include: the assembly, integration, checkout, and preflight preparation of space vehicles and their payloads; design, development, validation, activation, operation, and maintenance of ground support equipment (GSE) and supporting hardware; tracking and data acquisition; launch operations for reusable manned Space Shuttle vehicles; recovery and refurbishment of the Space Shuttle Solid Rocket Boosters (SRB's); landing operations and refurbishment of the Space Shuttle Orbiter; logistics support for flight operations; and design, construction, operation, and maintenance of launch and industrial facilities. KSC's responsibilities also extend to facilities and ground operations at designated contingency landing sites. Its location on the east coast of Florida is well suited for its mission by allowing initial launch trajectories to be over open ocean away from populated land areas. KSC is situated approximately 240 km (150 mi) south of Jacksonville and 64 km (40 mi) due east of Orlando on the north end of Merritt Island adjacent to CCAS. (KSC 1994)

At the ER, two takeoff sites, two landing sites, and two processing facilities are being considered for the X-33 Program: SLC-37, the Skid Strip, and the Solid Motor Assembly Building (SMAB) at CCAS; and KSC LC-39A/B, the Shuttle Landing Facility (SLF), and the Vehicle Assembly Building (VAB) at KSC (Figure 2.3-11).

SLC-37 at CCAS

SLC-37 was built in 1962 for the Saturn I Missile Program. It was the site of eight Saturn I and IB launches, including the launch of Apollo 5, with the first flight of an unmanned Apollo lunar module on January 22, 1968. The complex consisted of Pads A and B, each containing a launch stand and umbilical tower. Original structures common to the pads included the blockhouse (launch control center), operations support building, propellant storage and transfer facilities, two utility buildings, sentry house, sewage treatment plant (STP), sewage lift station, sewage pump house, electric substation, and a mobile self-propelled service structure riding on 366 m (1,200 ft) of steel rails between the two launch stands. The service structure was 91 m (300 ft) high and could extend to a distance of 101 m (330 ft). Much of the complex, including the service tower, has been dismantled and removed. The blockhouse, which contained the main firing and test supervision facilities, is still in place, although the interior is empty. The blockhouse measures 34 m (110 ft) in diameter by 11 m (37 ft) high and is constructed of reinforced concrete. (CCAS 1991, SFA 1995)

Skid Strip at CCAS

The Skid Strip is a 3,048 m long by 91 m wide (10,000 ft by 300 ft) northwest/southeast concrete runway provided with 23 m (75 ft) wide shoulders and 137 by 305 m (450 by 1,000 ft) grassy overruns. Overrun areas are stabilized. There are no return taxi lanes; however, a large cargo unloading/staging apron (4,253 sq m (45,776 sq ft)) and control tower have been constructed near

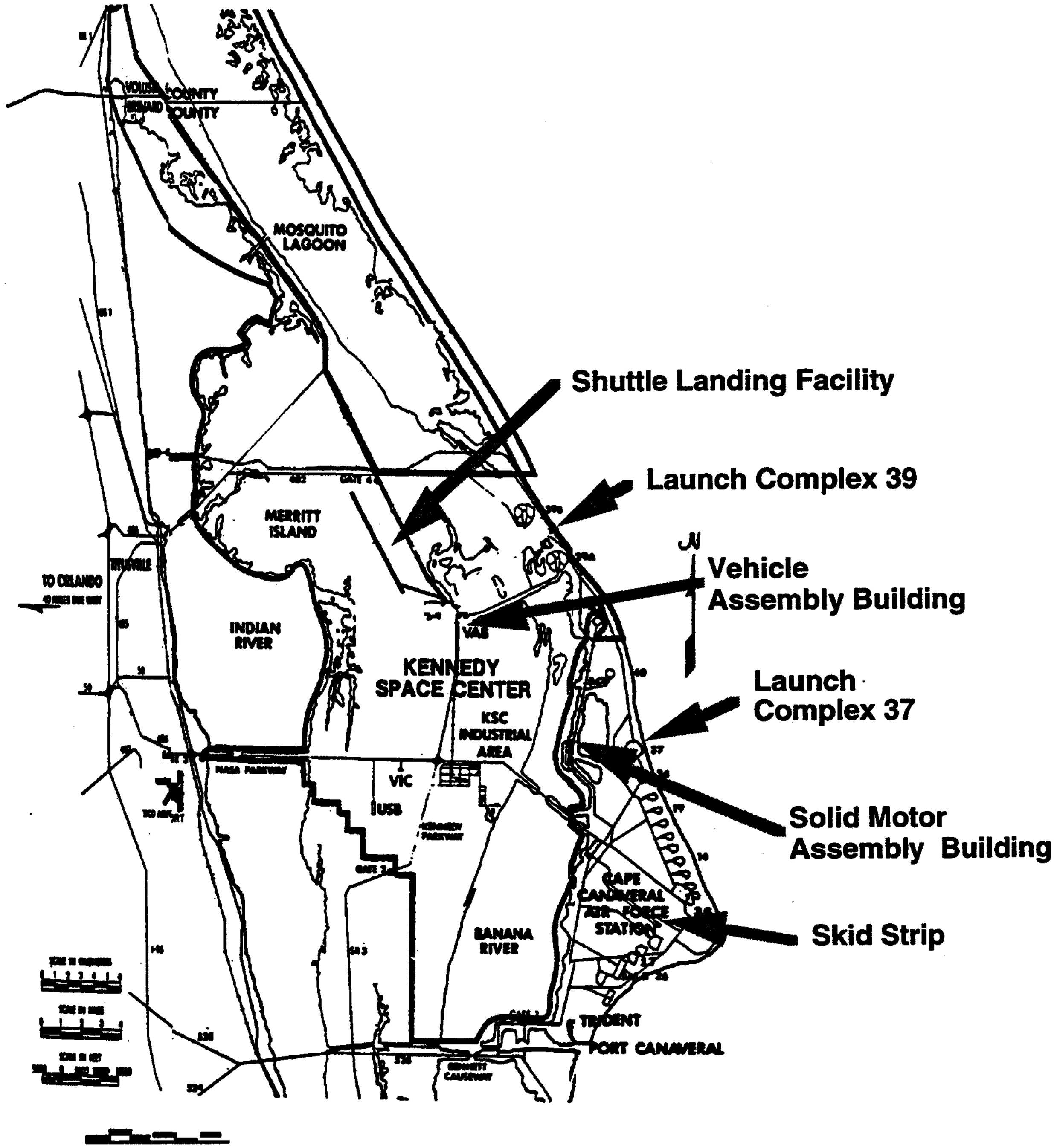


Figure 2.3-12. Eastern Range Area Map

the west end of the strip. The Skid Strip is classified as a Class B runway; both visual flight rules (VFR) and instrument flight rules (IFR) are supported. Air traffic is controlled from PAFB (26 km (16 mi) to the south). Aircraft operations on CCAS are limited to transport planes delivering missiles, spacecraft, or associated components. Occasionally, the Skid Strip has been used to receive visiting dignitaries or support missions for operations occurring at PAFB. Records show that annual utilization of the airfield fluctuates proportionately with launch activity on CCAS. The Skid Strip does not generate a large amount of air traffic, is located on an isolated peninsula, and does not impact civilian areas. (CCAS 1991, CCAS 1992)

SMAB at CCAS

The most suitable CCAS facility for X-33 spaceplane processing is the SMAB in the Titan Integrate Transfer Launch (ITL) area. By 1998, the SMAB will no longer be in use for stacking Titan IV solid rocket motors (although the associated Spacecraft Integration Facility (SPIF) payload processing facility will still be needed to support Titan IV and possibly evolved expendable launch vehicle (EELV) payloads). Some modifications will be required to accommodate the X-33 spaceplane, and exact requirements will be identified when the detailed design is known. The SMAB has an existing explosive safety/quantity distance (ES/QD) which would accommodate any projected propellant quantities for X-33 activities. ES/QD's are exclusion distances between facilities based on maximum explosive potential of stored propellants or other materials categorized as explosive. An exception to this assumption would be full dual-propellant fueling of the spaceplane, an activity currently contemplated to occur on the launch pad. (SFA 1995)

LC-39 at KSC

KSC LC-39 has two launch pads, A and B, which were originally designed to support the Apollo Program and were modified for Space Shuttle launch operations. Major changes included erection of a new Fixed Service Structure (FSS), addition of a Rotating Service Structure (RSS), and replacement of Saturn flame deflectors with three new flame deflectors. Fuel, oxidizer, high pressure gas, electrical, and pneumatic lines connect the Shuttle vehicle with GSE and are routed through the RSS, FSS, and Mobile Launch Platform (MLP). The RSS accommodates loading payloads vertically at the pad. It rotates on a semi-circular track through an arc of 120 degrees on a radius of 37 m (120 ft). Blast-protected hypergolic storage and supply systems are provided at each pad, and the Launch Processing System (LPS) is used to monitor all aspects of vehicle and payload operations. The FSS is topped by a 24 m (80 ft) tall fiberglass lightning mast grounded by 335 m (1,100 ft) cables anchored north and south of the pad. The mast provides lightning protection for pad structures and the Space Shuttle. Pads 39A and B are virtually identical and roughly octagonal in shape. The distance between pads is 2,657 m (8,715 ft). Each pad has an 18 m wide by 137 m long by 13 m deep (58 ft by 450 ft by 42 ft) flame trench. The Orbiter flame deflector is 12 m (38 ft) high, 22 m (72 ft) long, and 18 m (58 ft) wide and weighs 590,000 kg (1.3 million lb). The SRB deflector is 13 m (43 ft) high, 13 m (42 ft) long, and 17 m (57 ft) wide and weighs 499,000 kg (1.1 million lb). The Sound Suppression Water System is used to protect the launch structure from the intense sound pressure of liftoff. Its water tank is 89 m (290 ft) high and has a capacity of 1,135,000 L (300,000 gal). The pads also contain large LH_2 and LOX storage tanks. LOX tanks store 3,407,000 L (900,000 gal) at a temperature of -183 degrees C (-298 degrees F). LH_2 tanks store 3,220,000 L (850,000 gal) at a temperature of -253 degrees C (-423 degrees F). The Weather Protection System protects Orbiter tiles from windblown debris, rain, and hail. (KSC 1992, SFA 1995, KSC 1996-A)

SLF at KSC

The SLF is a concrete facility located approximately 3 km (2 mi) northwest of the VAB on a northwest to southeast (Runway 15) or southeast to northwest (Runway 33) alignment, with the launch pads only 5 to 6 km (3 to 4 mi) to the east. It is approximately 4,600 m (15,000 ft) long, 91 m (300 ft) wide, and 41 cm (16 in) thick at the center, with a 305 m (1,000 ft) paved safety overrun at each end. The SLF also has 15 m (50 ft) wide paved shoulders on each side. An array of visual aids as well as sophisticated guidance equipment at the SLF help guide the Orbiter to a safe landing. The Tactical Air Navigation (TACAN) system on the ground provides range and bearing measurements to the vehicle at an altitude of up to 44,200 m (145,000 ft). More precise guidance signals on slant range, azimuth, and elevation come from four sophisticated Microwave Scanning Beam Landing System (MSBLS) stations when the vehicle gets closer—5,500 to 6,100 m (18,000 to 20,000 ft). Visual aids are also provided by the Precision Approach Path Indicator (PAPI) system. A 168 by 146 m (550 by 480 ft) aircraft parking apron, or ramp, is located at the southeastern end of the runway. On the northeast corner of the ramp is the MDD which acts as a lift during ferry operations. Adjacent to the MDD is the Landing Aids Control Building, which houses equipment and personnel who operate the SLF on a daily basis. At the midfield point is the convoy staging area for the recovery team, control tower, fire station, and viewing area for press and guests. (KSC 1992, SFA 1995, KSC 1996-A)

VAB at KSC

The VAB was originally built for assembly of Apollo/Saturn vehicles and later modified to support Space Shuttle operations. High Bays 1 and 3 are used for integration and stacking of the complete Space Shuttle vehicle. High Bay 2 is used for ET checkout and storage and as a contingency storage area for Orbiters. High Bay 4 is also used for ET checkout and storage, as well as payload canister operations and SRB contingency handling. The Low Bay area contains Space Shuttle main engine maintenance and overhaul shops, and serves as a holding area for SRB forward assemblies and aft skirts. The VAB covers 3.3 ha (8 ac) and is 160 m (525 ft) tall, 218 m (716 ft) long, and 158 m (518 ft) wide. It encloses 3.7 million cubic m (129.4 million cubic ft) of space. The VAB has 71 cranes, including two 227 metric ton (250 ton) bridge cranes. The four high bay doors are 139 m (456 ft) high. The north entry to the transfer aisle was widened 12 m (40 ft) to permit entry of the Orbiter, and slotted at the center to accommodate its vertical stabilizer. The VAB can accommodate the X-33 spaceplane without any modifications to the building structure. (KSC 1992, SFA 1995, KSC 1996-A)

2.3.4 Generic Alternatives

2.3.4.1 Secondary Landing Sites

Secondary landing sites (i.e., landing sites remote from EAFB, WSMR, or the ER) are under consideration, but no determination of alternatives has been made. Designation of exact secondary landing sites and respective test flight corridors was not a requirement of CAN-1. Therefore, a number of alternative secondary landing sites could not be identified. The need and proposed geographical locations will be based on the ultimately proposed flight test expansion requirements and nonfeasibility or impracticality of landing on one of the proposed primary sites. Requirements for alternate landing sites include, but are not limited to: Government-controlled (or possibly privately controlled, but non-commercial airport) facilities; existing infrastructure such as a hard surfaced landing strip meeting the minimum requirements for safe landing of a horizontal landing spaceplane or available land for landing of a vertical landing spaceplane with necessary fire protection clear zones; non-interference with existing programs; and environmental acceptability for mitigating noise and risk impacts to the public and private property.

A generic profile of potential relevant environmental issues associated with landing at an alternate site is presented in this EA. Further comprehensive environmental analyses will be provided on alternatives under consideration following the decision and preferences in the Phase II Cooperative Agreement. The decision on final selection of alternate site(s) will be made by NASA following conclusion of the second X-33 environmental document, which will be referred to as EA-II in the reminder of this document, if there is a decision to continue the program. NASA will proceed with preparation of EA-II; however, if impact determinations cannot be supported with a Finding of No Significant Impact (FONSI), an Environmental Impact Statement (EIS) will ultimately be issued. With either document, EA or EIS, NASA intends to conduct public scoping meetings and issue the second EA or EIS in both draft and final form for public comment.

2.3.4.2 Test Flight Corridors

Test flight corridors with defined trajectories or paths between the primary site and landing site(s) will also be described in comprehensive detail in the X-33 EA-II. The major environmental issues of noise and safety (risk) are provided in this EA in a generic context. Proposed alternative flight corridors will be environmentally evaluated in the X-33 EA-II which NASA will use to make final flight test decisions.

2.3.4.3 Return to Primary Site Alternatives

Several alternatives are under early consideration for returning the X-33 spaceplane from a remote landing site. These alternatives include:

- Fly back on the Space Shuttle carrier aircraft currently used to return Space Shuttles from landings at EAFB to the launch site at KSC
- Rail
- Barge (ER alternative)
- Surface roads provided size and weight are acceptable
- Reflight using minimal takeoff support capability at the alternate site

Proposed alternative "return to primary site" transportation alternatives will be environmentally evaluated in the X-33 EA-II which NASA will use to make final flight test decisions.

2.3.5 No Action Alternative

The No Action Alternative for the X-33 Program is to not design, fabricate, and flight test the X-33 spaceplane, and consequently, to not demonstrate the potential ability to significantly reduce the cost of development, production and operation of future, new reusable spaceplane systems which could be commercially implemented. By implementing the No Action Alternative, the RLV Program could not proceed, resulting in continued reliance on existing Government-owned or controlled space launch vehicles such as the Space Shuttle, capable of carrying payloads, cargo, and humans, with its reusable Orbiter and boosters and expendable external (LOX/LH_2) tank, and expendable launch vehicles such as the Titan IV, Delta, and others, capable of carrying only payloads and cargo. These existing launch vehicles have been the subject of previous environmental documentation which will be used for environmental comparative purposes with no further assessment. (NASA 1978, GSFC/WFF 1994, DOT 1986, DOT 1992, CCAS 1986, CCAS/VAFB 1990, VAFB 1991, CCAS 1991, USAF 1994)

2.3.6 Alternatives Considered But Not Carried Forward

2.3.6.1 Primary Sites

During Phase I, two additional primary sites for operations and flight tests were considered: Vandenberg Air Force Base (VAFB), California, and Wallops Flight Facility (WFF), Virginia. Although assets and facilities at both sites were considerable, with VAFB containing more than WFF, there were overriding advantages at EAFB, WSMR, and the ER. However, selection of the primary site for the X-33 Program has no necessary correlation with the primary site for a commercial RLV Program, if one is undertaken.

2.3.6.2 Propulsion Systems

Initially, tripropellant engine technology using a combination of LH_2 and RP-1 (a highly refined petroleum product classified in the kerosene family) as the fuel source and LOX as the oxidizer was considered as an alternative propulsion system for use on the X-33 spaceplane. All tripropellant engine technology is Russian, and sufficient data are not available in the U.S. to determine risk, reliability, and life cycle costs.

3.0 Affected Environments

3.1 Primary Sites

3.1.1 EAFB/ AFFTC/DFRC

This section discusses the affected environment for takeoff and landing sites on EAFB described in Section 2.3.3.1.

3.1.1.1 Facilities and Infrastructure

Wastewater Treatment

Three separate systems collect and treat wastewater on the base, with each system designed to serve a specific area. The Main Base wastewater treatment plant (WWTP) serves both Main Base and South Base. The WWTP provides primary treatment, disposing of the effluent through evaporation ponds. The second and third WWTP's are located at North Base and PL. Both facilities are considerably smaller than the Main Base WWTP, both use an inground Imhoff tank, and both discharge directly to evaporation ponds. DFRC wastewater drains through a network of sanitary sewer lines to the EAFB WWTP. A tertiary treatment plant began operations in 1996; Main Base, North Base, and DFRC are connected to it. (EAFB 1994-A, DFRC 1996)

Electricity

EAFB receives electricity from Southern California Edison and the Western Area Power Administration (WAPA). A 115-kilovolt (kV) line enters the North Base where it serves two 115/34-kV substations. The substations in turn supply electrical service to the North Base, Main Base, and PL. The 115-kV transmission line continues from substations to the South Base, where it feeds a 25-megavolt-ampere (MVA), 115/34-kV substation. Electric power is received at 34.5 kV, and most of the electrical facilities are overhead. Exceptions are the main housing area and all lines along Wolfe Avenue and the flight line area. DFRC is connected to this electrical system and all lines there are underground. Several emergency power generators are available to provide backup power. (EAFB 1994-A, DFRC 1996)

Communications

The Command, Control, Communications, and Computer Systems (C4) provides EAFB electronic support. The AFFTC Telecommunications Facility and Distribution System provides telephone services, voice mail, Defense Switch Network (DSN), and Federal Telephone Service (FTS 2000). The system is connected with an 80.5 km (50 mi), 48-strand, single-mode fiberoptic loop. All AFFTC core facilities, North Base, South Base, and PL are connected to the fiberoptic ring. Only 4 of the 48 strands are required to support the telephone system, leaving 44 strands available for computer networking and future growth. The land mobile radio system is a trunked system. A state-of-the-art computer-controlled ultrahigh frequency (UHF) network allowing over-the-air net customizing enables users to change who they are talking to and who can listen to their transmission. In addition, the system is Digital Encryption Standard (DES) compatible. The Air Traffic Control and Landing System (ATCALS) and meteorological systems provide users with ground-based flight navigational systems, which receive and transmit safety of flight information to air and ground-to-ground radio equipment. The systems currently operating include: AN/FRN 45 Very High Frequency (VHF) Omni Range/Tactical Air Navigational (VOR/TAC), AN/GRN-29 Instrument Landing System (ILS), ML-658 Digital Barometer (DBASI), FMQ-8 Temp Dewpoint, FMQ-13 Digital Winds, GMQ-34 Laser Beam Ceilometer, TQM-36 Tactical Winds, GMQ-20 Wind/Speed/ Direction, Rivet Switch receiver and transmitter, and the Next Generation Radar (NEXRAD) Weather System.

Natural Gas

Pacific Gas and Electric provides natural gas from two 91 cm (36 in) diameter transmission lines paralleling State Highway 58 north of the base. A 15 cm (6 in) pipeline branches off into the base and provides gas at 1,030 kPa (150 psi). Feeder lines provide gas to the Main Base, North Base, South Base, DFRC, and the core area of PL. (EAFB 1994-A, DFRC 1996)

Fuel

Jet fuels (JP-4, JP-5, JP-7, JP-8, and JP-10) as well as diesel fuel, regular leaded and unleaded gasoline, and fuel oil are stored at EAFB and managed by the Fuels Management Branch. Petroleum products are stored in 13 aboveground storage tanks (AST's) and 12 underground storage tanks (UST's). Fuel storage capacities include approximately 9.2 million L (2.4 million gal) of JP-8 (the primary jet fuel at EAFB); 3.8 million L (1.0 million gal) of JP-7; 454,000 L (120,000 gal) of JP-5; 1.2 million L (325,000 gal) of diesel; 3.4 million L (900,000 gal) of gasoline; and 950,000 L (250,000 gal) of fuel oil.

The array of fuels requires several separate distribution systems. JP-8 is delivered by a 15 cm (6 in) pipeline to the main tank farm into either a 3.2 million L (840,000 gal) or a 1.5 million L (400,000 gal) tank. The pipeline is maintained and operated by the California-Nevada Pipeline Company. From the storage area, fuel is gravity fed to the Hydrant 1 system, which contains four 190,000 L (50,000 gal) UST's; or to the Hydrant 3 system, which contains two internal floating roof tanks with a 1.5 million L (400,000 gal) capacity. Aircraft fueling occurs via both hydrant and refueling trucks.

Other fuels are delivered via refueling truck. In the South Base area, JP-8 is stored in two 190,000 L (50,000 gal) UST's at Facility 1873, three 57,000 L (15,000 gal) and three 95,000 L (25,000 gal) AST's at Facility 4511, and two 400,000 L (105,000 gal) tanks in the general vicinity. Petroleum products are also stored at the flightline service station in three 95,000 L (25,000 gal) tanks and at the military service station. (EAFB 1994-A)

EAFB has the facilities to store 45,400 L (12,000 gal) of LH_2, and pump and dispose of LH_2 through controlled "evaporation" at test area 1-52C. Test stand 1A at area 1-120 is being modified for testing EELV engines. A 341,000 L (90,000 gal) LH2 tank and a 284,000 L (75,000 gal) LOX tank, along with associated piping and flare stacks, are being readied for initial test in September 1995. Tank for LOX and LH_2 required to fuel the X-33 spaceplane will be placed adjacent to the selected takeoff site.

Hazardous Waste

EAFB is operating in an interim status as a large quantity generator of hazardous waste pending the U.S. Environmental Protection Agency's (EPA's) processing of its renewal application. In 1992, approximately 10,300 kg (22,600 lb) per month of hazardous waste were generated. EAFB has drum storage capacity for 153,000 L (40,500 gal) of hazardous waste. It currently operates at an average of 50 percent capacity.

A hazardous waste management plan has been prepared and implemented to ensure compliance with Resource Conservation and Recovery Act (RCRA) requirements. The plan establishes specific policies, responsibilities, and procedures for hazardous waste management operations, including petroleum products and polychlorinated biphenyls (PCB's). Personnel who manage or handle hazardous waste must receive annual safety and documentation protocol training, in addition to annual RCRA and Occupational Safety and Health Administration (OSHA) Hazard Communication training. (EAFB 1994-A)

Hazardous waste is stored at various satellite accumulation areas near the points of generation, where up to 210 L (55 gal) of hazardous waste or 1.0 L (1 qt) of an acute hazardous waste can be stored up to 1 year. Waste is then transferred to designated accumulation points or treatment, storage, and disposal facilities for offsite recycling or disposal by permitted contractors. (EAFB 1994-A)

Solid Waste

Solid waste generated on EAFB is disposed of in the Main Base landfill located approximately 2.1 km (1.3 mi) north of the family housing area. The permitted Class III landfill accepts nonliquid, nonhazardous wastes including residential, construction/demolition, commercial, and industrial wastes. Principal areas contributing solid waste to the facility are the Main Base, South Base, North Base, and PL. The landfill is owned and operated by the USAF and is not open to the public. DFRC currently ships solid waste offsite, but arrangements are being made to use the EAFB landfill. Recycling and salvaging operations are managed by the EAFB Environmental Management Group. Recycled materials include newspapers, magazines, shredded high-grade white paper, high density polyethylene (HDPE) plastic, clear and colored glass, and ferrous and nonferrous metals. On-base waste collection is accomplished by private contractors. (EAFB 1994-A, DFRC 1996)

3.1.1.2 Air Quality

EAFB is located in the northwest portion of the Southeast Desert Air Basin (SEDAB). The SEDAB consists of the desert part of San Bernardino and Riverside counties, the eastern parts of Kern and Los Angeles counties, and all of Imperial County. Most of the base lies in Kern County, with small portions in Los Angeles and San Bernardino counties. The desert portions of Los Angeles and San Bernardino counties are classified by EPA as nonattainment for ozone (O_3), while the desert area for Kern County is unclassified. The attainment designation for carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulates (PM_{10}) in the desert area of all three counties is unclassified. All three counties are classified by the California Air Resources Board as nonattainment for O_3 and PM_{10}. Los Angeles and San Bernardino counties are classified by the Board as attainment for CO, NO_2, and SO_2. Kern County is classified by the Board as attainment for CO and SO_2. (EAFB 1994-A)

The closest and most representative air quality monitoring station is located in Lancaster, about 3.2 km (2.0 mi) southwest of EAFB. O_3 and PM_{10} concentrations exceeded both state and federal ambient standards from 1989 through 1991.

Pollution emissions inventories were prepared in 1992 for EAFB and the Kern County portion of the SEDAB. The emission inventory, prepared by the Kern County Air Pollution Control District (APCD), includes only emissions from stationary sources. Emissions from mobile sources, such as motor vehicles and aircraft, were not calculated. EAFB contributes approximately 43 percent of the hydrocarbon burden to the Kern County portion of the SEDAB and 2 percent or less to the burden of the other criteria pollutants (CO, No_x, So_x, and PM). (EAFB 1994-A)

In 1987, the California Legislature enacted Assembly Bill 2588 establishing a process for inventorying selected toxic substances, determining health risks, and notifying the public regarding these risks. The EAFB 1992 emission inventory identified 82 air toxic compounds listed by the California Air Resources Board. The total emission rate of these compounds was 77.58 tons per year. Of the 82 compounds, 24 are considered carcinogenic. The total emission rate of the carcinogenic compounds is about 7 tons per year. (EAFB 1994-A)

Transport of air pollutants to EAFB occurs from the South Coast Air Basin through Soledad Canyon, the San Joaquin Valley Air Basin, the San Francisco Bay Area, and the Tehachapi Mountain Pass. It is possible that increased growth in the southern portion of the San Joaquin Valley may affect the air quality in the western Mojave Desert. (EAFB 1994-A)

3.1.1.3 Airspace

The Edwards Control Tower separates and sequences aircraft in the airspace immediately surrounding the airport installation. Service includes aircraft on either IFR or VFR clearances.

Radar-monitored air traffic control is provided by Air Route Traffic Control Centers (ARTCC's). Los Angeles Center located at Palmdale, California (one of the busiest in the United States), provides control of civil and military IFR air traffic and some service to VFR air traffic, which transits the airspace on three sides of the R-2508 Complex. Oakland Center manages the airspace north of the Complex.

The R-2508 Complex is a tri-service test complex used by DOD for test and evaluation of piloted and remotely piloted aerospace vehicles and weapon system technologies. R-2508 occupies over 32,000 sq km (20,000 sq mi) in an area approximately 274 km (170 mi) long north to south and ranging in width from approximately 111 to 163 km (69 to 142 mi). The Complex is managed by the three principal military activities in the region: AFFTC, EAFB; Naval Air Warfare Center (NAWC), China Lake; and National Training Center (NTC), Fort Irwin. R-2508 contains seven Restricted Areas depicted in Figure 3.1-1.

One-fourth (25 percent) of all air traffic control activities for the Los Angeles Center occurs in the nine sectors containing or surrounding the R-2508 Complex. Based on historical data, the Federal Aviation Administration (FAA) forecasts an average annual growth in aircraft operations between 4.5 and 6.0 percent. Aircraft operations during 1996 should be approximately 60,000 per month.

3.1.1.4 Biological Resources

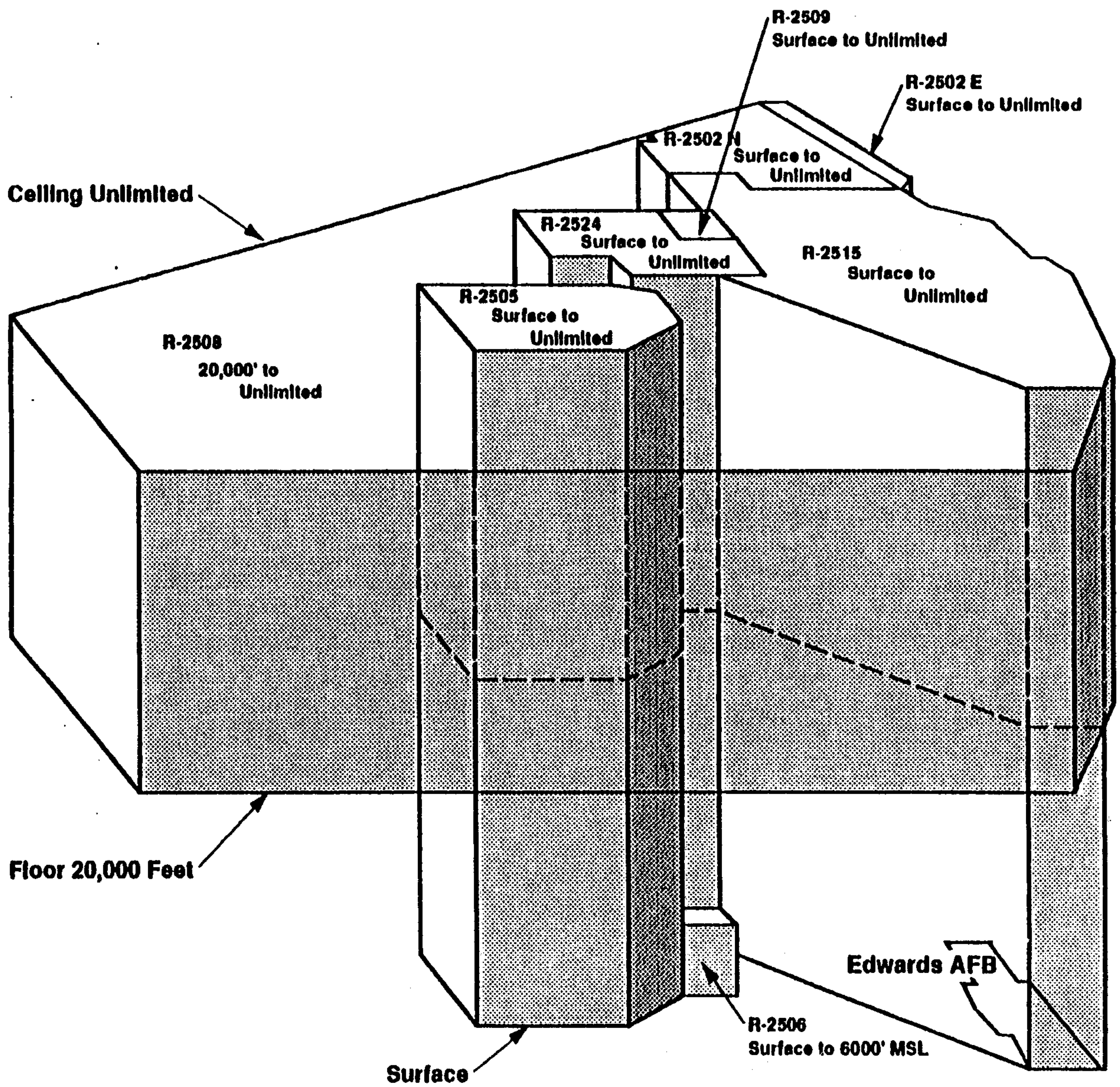
Biological resources include native and introduced plants and animals and their respective habitats. The two regions of influence are site areas where ground disturbance or operations may affect biological resources and the overflight area.

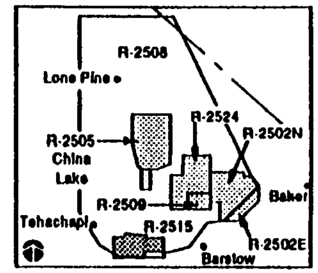
The region of influence for ground support includes: the South Base Site, Spaceport 2000 Site 1, Spaceport 2000 Site 2, and the NASA-North Base Site. Use of other overlay facilities is not expected to affect biological resources, except by reducing the amount (0.2 to 2.4 ha (0.5 to 6.0 ac)) of ground disturbance at the proposed site in South Base. For discussion purposes, each area is divided into vegetation, wildlife, and sensitive habitats.

Overflight areas are considered with respect to potential noise impacts on biological resources; consequently, only wildlife (including threatened or endangered wildlife) and domestic animals are considered. The affected area for overflight is limited to the R-2508 Complex area.

<u>Vegetation</u>

South Base Site, Spaceport 2000 Sites 1 and 2: Vegetation is a halophytic phase of saltbush scrub dominated by a variety of low shrubs. The most common are Mojave saltbush or spinescale (*Atriplex spinifera*) and allscale (*Atriplex polycarpa*). Plant communities on EAFB are shown in Figure 3.1-2. Also prevalent are Anderson desert thorn or wolfberry (*Lycium andersonii*), Nevada tea (*Ephedra nevadensis*), spiny hopsage (*Grayia spinosa*), and patches of peach-thorn (*Lycium cooperi*), Cooper's goldenbush (*Haplopappus coperi*), Alkali goldenbush (*H. acradenius*), matchweed (*Gutierrezia microcephala*), rabbitbrush (*Chrysothamnus* sp.), and occasional great basin sagebrush (*Artemisia tridentata*). A few tamarisks (*Tamarix* cf. *pentandra*) and relatively large mesquites are present. Vegetated areas grade rather abruptly into the unvegetated playa of





Source: AFFTC regulation 55-2, vol. I

Figure 3.1-1. R-2508 Complex Restricted Areas

THE PLANT COMMUNITIES OF EDWARDS AFB

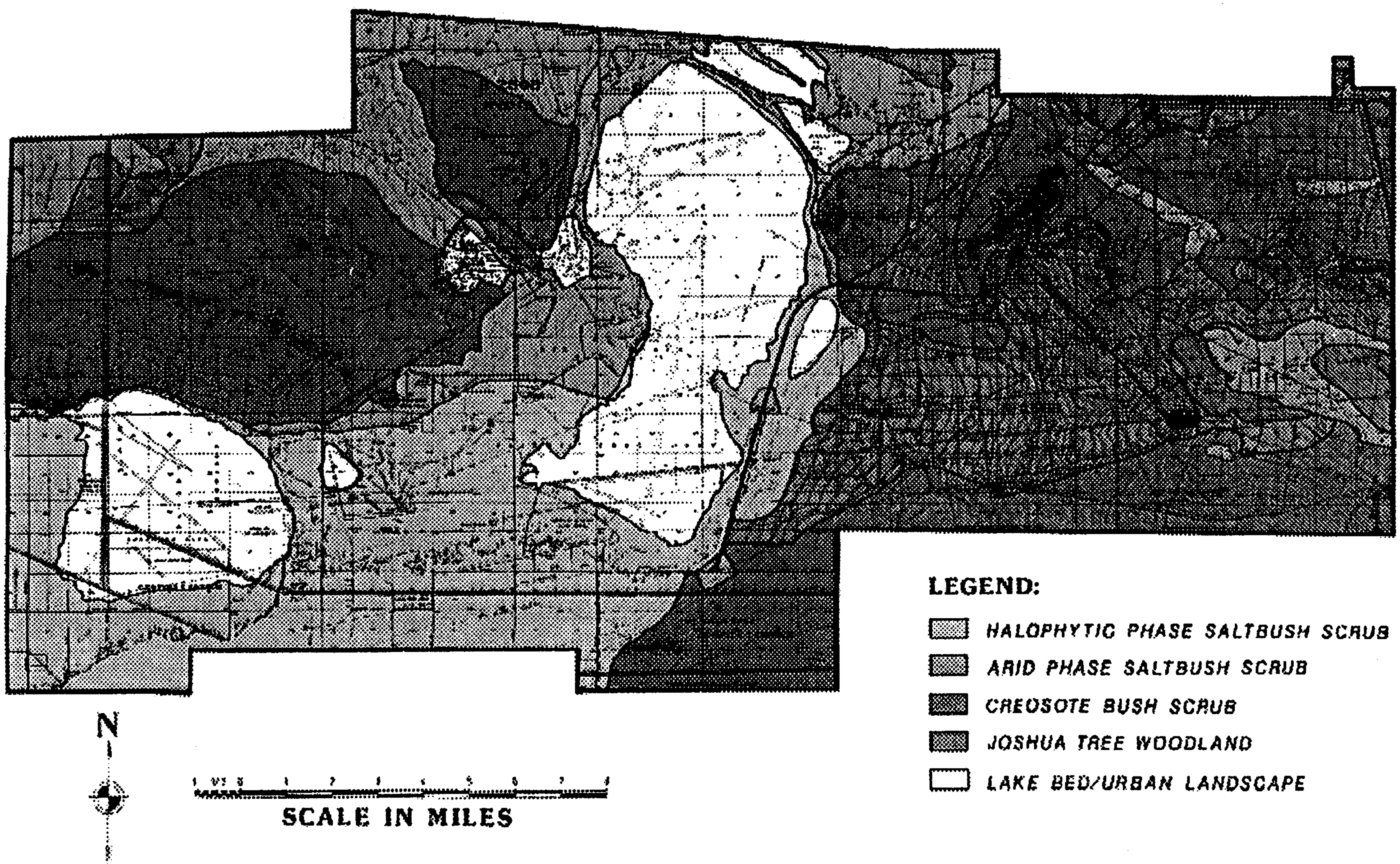


Figure 3.1-2. EAFB Vegetation Map

Rogers Dry Lake in the eastern portion of the site. Naturally revegetated, disturbed areas are relatively frequent, most probably being associated with activities dating from the 1940's or 1950's. (EAFB 1992)

NASA-North Base Site: The site is dominated by an arid phase of saltbush scrub, but with a shrub cover more strongly dominated by Mojave saltbush (*Atriplex spinifera*) and with fewer associated scrubs than the three Southern sites. Shrubs are nearly absent from the adjacent playa area, except where areas have been disturbed (e.g., by trenching) or where soil has accumulated a few centimeters (inches) above the prevailing elevation of the playa. Scattered creosote bushes are also present. (EAFB 1992)

Phillips Laboratory: PL is an existing facility on Leuhman Ridge in the northeastern portion of EAFB. The ridge, which includes rock outcrops and creosotebush scrub habitat with relatively extensive Joshua tree cover, has been extensively developed for engine testing and related activities. (EAFB 1992)

Main Base Rail Spur Alignment: Vegetation is predominantly saltbush scrub similar to that found on the Western Site. Vegetation is sparse near the northern end of the alignment. The alignment crosses one area where native vegetative cover has been previously removed and recently reseeded in an attempt to reestablish native plants. West of this area, where alignment parallels Wolfe Avenue, native vegetative cover is relatively undisturbed saltbush scrub dominated by allscale (*Atriplex polycarpa*). Immediately north of Wolfe Avenue is a broad, recently cleared area. South of Wolfe Avenue, the spur parallels Lancaster Boulevard and runs through relatively homogeneous saltbush scrub dominated by allscale and Mojave saltbush (*Atriplex spinifera*). Numerous claypans associated with a low gradient drainageway and scattered plants of Torrey's sea blite (*Suaeda torreyana*), a halophytic shrub not found elsewhere on the rail spur alignment, are found in the area. (EAFB 1992)

Rosamond Boulevard Rail Spur Alignment: A variety of vegetation and soil types are found in this area. From its origin near the junction of Lancaster and Rosamond Boulevards, the rail spur passes through creosote bush scrub dominated by creosote bush (*Larrea tridentata*) and white bur-sage (*Ambrosia dumosa*). Scattered Joshua trees (*Yucca brevifolia*) are also present. Rings of Cooper desert thorn (*Lycium cooperi*) and Anderson desert thorn (*Lycium andersonii*) ranging in diameter up to about 6 m (20 ft) are an unusual feature that is prevalent. Creosote bush scrub reaches its lower elevational limit abruptly at about Mojave Boulevard, leaving a sparse shrub community on sandy soils dominated by cheesebush (*Hymenoclea salsola*), which gives way to saltbush scrub dominated by *Atriplex polycarpa* on finer textured soils near Rosamond Boulevard. This community continues southward to Wolfe Avenue where the alignment merges with the Main Base rail spur alignment. (EAFB 1992)

Wetlands and Floodplains

EAFB contains numerous playas, pools, clay pans, and several springs. Although most of these areas have not been delineated as jurisdictional wetlands by the U.S. Army Corps of Engineers

(COE), many of them serve as biological wetlands. These areas support freshwater shrimp, hydrophytic plants, waterfowl, and shorebirds, as well as provide watering areas for large mammals. In the southwest area of the base between Rosamond Dry Lake and Rogers Dry Lake, a continuum of larger playas exists, containing several smaller dry lakebeds. The area northeast of Rogers Dry Lake and west of Rich Road also contains many larger playas and lakebeds. These areas, combined with the lakebeds, form a band that extends across the base from Piute Ponds in the southwest corner to the northern base boundary west of Rich Road. Smaller isolated playas and clay ponds are found in nearly all other areas of the base as well. (EAFB 1994-A)

A flood study conducted in 1992 by GRW Engineers identified 100 year floodplains that encompassed Rogers, Rosamond and Buckhorn dry lakes and the immediately surrounding areas, as well as the area along Mojave Creek. Flooding has also been known to occur in some low lying areas of the Main Base. All of the proposed takeoff sites are near, but not inside, the 100 year floodplain. (EAFB 1994-A)

<u>Wildlife</u>

South Base Site, Spaceport 2000 Sites 1 and 2: Common mammals known or expected to occur include: the black-tailed jackrabbit (*Lepus californicus*), coyote (*Canis latrans*), desert cottontail (*Sylvilagus audubonii*), and kit fox (*Vulpes macrotis*), which utilize all habitat types of the area except those substantially altered by human activity. The antelope ground squirrel (*Ammospermophilus leucurus*), Merriam's kangaroo rat (*Dipodomys merriami*), southern grasshopper mouse (*Onychomys torridus*), and little pocket mouse (*Perognathus longimembris*) occur in saltbush scrub with loose, sandy soils. Pallid bats (*Antrozous pallidus*) and western mastiff bats (*Eumops perotis*) are also found in the area. (EAFB 1992)

Indigenous birds include: the common raven (*Corvus corax*), horned lark (*Eremophila alpestris*), loggerhead shrike (*Lanius ludovicianus*), mourning dove (*Zenaida macroura*), quail (*Callypepla california* sp.), greater roadrunner (*Geococcyx californianus*), lesser nighthawk (*Chrodeiles acutipennis*), Say's phoebe (*Sayornis saya*), thrasher (*Toxostoma* sp. including LeConte's thrasher *[Toxostoma kecontei]* and Bendire's thrasher *[Toxostoma bendirei]*), white-crowned sparrow (*Zonotrichia leucophrys*), and song sparrow (*Melospiza melodia*). Raptors such as the red-tailed hawk (*Buteo jamaicensis*), turkey vulture (*Cathartes aura*), American kestrel (*Falco sparverius*), barn owl (*Tyto alba*), and great horned owl (*Bubo virginianus*) are likely to forage in the desert scrub. The rock dove (*Columba livia*), barn owl, and house finch (*Carpodacus mexicanus*) are associated with developed areas in the vicinity. The golden eagle (*Aquila chrysaetas*) also occurs during migration seasons. Burrowing owls (*Athene cunicularia*) may nest within the area. (EAFB 1992)

Reptiles are abundant. Resident species include: the side-blotched lizard (*Uta stansburiana*), California whiptail (*Cnemidophorus tigris*), zebra-tailed lizard (*Callisauris draconoides*), desert spiny lizard (*Sceloporus magister*), desert horned lizard (*Phrynosoma platyrhinos*), long-nosed leopard lizard (*Gambelia wislizenii*), western patch-nosed snake (*Salvadora hexalepis*), Mohave rattlesnake (*Crotalus scutulatus*), and western shovel-nosed snake (*Chionactis occipitalis*). (EAFB 1992)

Scattered mesquite and Joshua trees present on the three Southern sites are a locally important resource to wildlife.

NASA-North Base Site: Wildlife species composition is very similar to that of the three Southern sites.

Phillips Laboratory: Wildlife at PL includes many of the same species as the three Southern sites. Bobcats (*Felis rufus*), prairie falcons (*Falco mexicanus*), and rock wrens (*Salpinctes obsoletus*) also occur. (EAFB 1992)

Main Base Rail Spur Alignment: Wildlife within the Main Base rail spur alignment is similar to that described for saltbush scrub habitats of the three Southern sites. (EAFB 1992)

Rosamond Boulevard Rail Spur Alignment: Wildlife species composition is similar to that of the three Southern sites. Antelope ground squirrel, jackrabbits, and cottontail rabbits, along with abundant small rodent signs, have been observed. Creosote and Joshua trees provide habitat for several observed bird species such as western kingbirds, sage sparrows, and LeConte's thrasher. (EAFB 1992)

Reptiles are abundant and of the same species as those described for the three Southern sites. (EAFB 1992)

3.1.1.5 Threatened, Endangered, and Sensitive Species

A portion of EAFB has been designated by the U.S. Fish and Wildlife Service (USFWS) as critical habitat for the desert tortoise, a federal and state threatened species. Parts of the base that have been affected by this action include the eastern part of the Precision Impact Range Area (PIRA), portions of PL, and the Complex One Charlie area in the extreme southern section of the base.

During 1992-1993, relative density transects indicated that desert tortoise density within the area of critical habitat averaged greater than 15 tortoises per 2.6 sq km (1 sq mi). The southeast portion of the base appears to support the highest densities, with an additional area of relatively high density habitat in the northeast. Rosamond Hills and Bissell Hills in the northwest portion of the base also appear to harbor relatively high numbers of tortoises. The saltbush scrub, which dominates the southwest and central areas, appears to be the least productive area for the species, with 0-6 per 2.6 sq km (1 sq mi). (EAFB 1994-A, DFRC 1996)

The Mojave ground squirrel, a state listed threatened species and Category 2 species under review by USFWS for federal listing as threatened or endangered, occurs in several areas. Potential habitat is available on much of EAFB. The area between Buckhorn Dry Lake and Mercury Boulevard, south of Rogers Dry Lake, supports the highest relative abundance of the species, but it appears in varying abundance throughout much of the less developed areas. (EAFB 1994-A, DFRC 1996)

No federal or state listed threatened or endangered plants have been found on EAFB, but eight plant species listed by the California Native Plant Society (CNPS) have been identified. (EAFB 1994-A, DFRC 1996)

For a complete listing of threatened, endangered, and sensitive species see Appendix B.

3.1.1.6 Cultural Resources

Approximately 800 historic sites have been recorded on EAFB. Sites include trash scatters, town sites, homesteads, agricultural features, ranching features, mines and mining camps, railroad-related features, military structures and features, and historic rock features. The northern portion of Rogers Dry Lake has been designated as a National Historic Landmark for its involvement in the Manned Space Flight Program. (EAFB 1994-A)

Native American cultural resources include burial and cremation sites. Consultation with the State Historic Preservation Office (SHPO) and tribal groups will be conducted to determine if these sites are sensitive resources. Responses will be provided in the X-33 EA-II. (EAFB 1994-A)

Approximately 580 prehistoric sites (areas containing resources resulting from human activities that predate written records) have been recorded. Site types include villages, temporary camps, rockshelters, milling stations, lithic scatters, quarries, cremations, rock features, hearths, rock art, and bone scatters. Approximately 30 sites have been formally evaluated for eligibility to the National Register of Historic Places (NRHP). About 12 sites have been recommended as NRHP eligible, and the California SHPO has concurred with the recommendations. (EAFB 1994-A)

3.1.1.7 Water Resources

EAFB is located in a basin that is essentially closed with respect to both surface drainage and groundwater movement. Most of the precipitation of the region falls in the higher elevations to the west and south. In time the water is carried by subsurface and surface flow from those areas to the lower elevations. Much of this water evaporates or infiltrates the ground. Average annual rainfall is 13 cm (5 in). There are no perennial streams on or near the base. No natural ponds exist, and lakebeds are dry except during rainy seasons. Lakebeds and normally dry stream channels may be subject to flooding after an unusually heavy storm. Groundwater resources are supplemented with water supplied by the Antelope Valley East Kern (AVEK) Water District through a state water project. Water table levels have declined due to groundwater overdrafting for the last 40 years. (EAFB 1992)

Major surface water features are three dry lakebeds (Rogers Dry Lake, Rosamond Dry Lake, and Buckhorn Dry Lake), portions of the claypan system, and several manmade lakes and ponds, many of which are part of wastewater and stormwater holding treatment facilities. (EAFB 1992)

Most water used on base is obtained from local groundwater sources from four Wellfields (South Base, South Track, North Base, and PL). In addition, approximately 7.6 million L (2 million gal) of water per day are obtained from AVEK. The old Main Base Wellfield and most pre-EAFB wells have been abandoned. There are currently six active wells in the South Base and South Track Wellfield. The North Base Wellfield has one active well. PL receives water from five active wells in the Rocket Site Wellfields. DFRC purchases water from the EAFB water system. The distribution system consists of a series of pipes ranging in size from 15 to 36 cm (6 to 14 in) in diameter, booster pump stations, and storage tanks. (EAFB 1992)

Average daily water demand is 15 million L per day (mLd) (4 million gal per day (mgd)), with a projected future demand of 17 mLd (4.5 mgd). Peak daily potable water demand is 39 mLd (10 mgd) with future peak demand predicted to be 44 mLd (12 mgd). Present maximum capacity is 63 mLd (17 mgd). (EAFB 1994-A, DFRC 1996)

Groundwater

The following focuses on the particular hydrological attributes most likely to be affected by the alternative; i.e., groundwater levels. Because groundwater at some sites is potentially contaminated, information is also provided on existing hazardous waste conditions and status of remedial investigation and feasibility studies. The region of influence for hydrology includes the Antelope Valley watershed or the Lancaster and North Muroc Sub-Basins. (EAFB 1992)

The Antelope Valley, one of the largest groundwater basins in southern California, is divided into sub-basins bounded by faults or other relatively impermeable groundwater barriers. The southern part of EAFB, from which most EAFB water is pumped, and AF Plant 42 are in the Lancaster sub-basin. (EAFB 1992)

Groundwater follows the same general patterns as surface water with flow from recharge areas at the basin margins to discharge areas in the valley. Before extensive groundwater pumpage began, springs and seeps were common around the dry lakes, and wells flowed without pumping in an area of more than 600 sq km (250 sq mi) at the turn of the century. Groundwater levels dropped rapidly with extensive agricultural development during the first half of the century, and groundwater depressions, which still exist, formed in areas with high pumpage rates. However, as awareness of the problem increased and cost of pumping water from greater depths made agricultural use less economical, importation of water from northern California began and groundwater levels dropped less rapidly. Although current pumpage still greatly exceeds the safe yield of the basin of 51,000 million L (13,400 million gal) of water per year estimated in 1975, groundwater elevations leveled and in some cases even rose during the 1980's. Groundwater use, which was approximately 159,000 million L (42,000 million gal) in 1983, was projected to increase to approximately 190,000 million L (50,000 million gal) per year in the year 2000. This rate includes industrial, residential, and agricultural water use as well as groundwater pumped at EAFB. (EAFB 1992)

The South Base and South Track Wellfields are in the Lancaster subunit, which also supplies water to agricultural communities south of the base. Limited amounts of water are pumped from the North Base Wellfield in the North Muroc subunit. Remote facilities, such as the golf course, are supplied by wells not connected to the main domestic water supply system. The 1990 rate of pumpage was approximately 7,500 million L (2,000 million gal) through the baseline year 1993. Groundwater levels dropped rapidly during the first half of the century and leveled off in the 1960's and 1970's. However, a depression has formed in the groundwater table around the South Base and South Track Wellfields, which supply most of the water pumped by the base. Water levels remain fairly stable in isolated wells, but drop more rapidly in wells in South Base and South Track Wellfields. (USAF 1992-C)

The 45 mLd (12 mgd) allocation from the AVEK Water Agency will reduce pumping requirements. EAFB's current plan is to use the AVEK allocation instead of the North Base Wellfield. (EAFB 1992)

AF Plant 42

The water table is approximately 75 to 130 m (250 to 400 ft) below ground surface with flow toward the north and northeast. (EAFB 1992)

3.1.1.8 Geology and Soils

Seismicity

EAFB is located in a relatively aseismic or inactive earthquake area relative to the rest of Southern California. Active and potentially active faults located in the region that may have the greatest potential to generate significant strong ground motion (earthquakes) are the San Andreas and Garlock faults. No faults are known to occur beneath the four proposed EAFB sites, and these sites are not located within an Alquist-Priolo Special Studies Zone (Hart 1990). The nearest faults considered to have potential for ground surface rupture are the Mirage Valley fault, located approximately 3 km (2 mi) southeast of the sites; and possibly the North Muroc fault, located approximately 4 km (2.5 mi) north of the sites. Based on the medium to very dense soils, potential for seismic settlements or differential compaction is considered to be low. (EAFB 1992)

Land Subsidence/Fissuring and Liquefaction

Subsidence and liquefaction are two geologic phenomena that can result from seismic activity. Subsidence is any settling or sinking of the ground surface arising from surface or subsurface causes. Its usual form is a dish-shaped or bowl-shaped region of downward surface displacements. Some types of subsidence can be the result of natural processes, including natural compaction of loosely consolidated alluvium, as well as tectonics and earthquakes. Other types are caused by human activities. Subsidence and earth fissures have been documented at numerous locations within the Antelope Valley. Given the relatively shallow depth to bedrock beneath the sites, lack of groundwater overlying alluvium, and lack of any fissures or fissure-related features at the sites, ground fissures, faults, or subsidence are unlikely to occur. (EAFB 1992)

Liquefaction is a process by which loose, water-saturated granular materials (silt, sand, or gravel) behave for a short time as dense fluid rather than a solid mass, usually as a result of ground shaking of high intensity and long duration. Prerequisite conditions are shallow groundwater (typically less than 15 m (50 ft)) and saturated, loose, cohesionless, granular soils. Occurrence of liquefaction is considered to be minimal or nonexistent due to the thin cover of soil overlying bedrock and lack of groundwater in the alluvium. (EAFB 1992)

Lowering the water table in clay-rich sediments such as playa lakebeds with high shrink/swell potential can cause the clay to contract. Land surface can subside and large desiccation fissures called mudcracks can form. Since 1920, mudcracks have been found on Rogers Dry Lake. By 1968, approximately 20 percent of the playa was covered with polygons. New fissures continue to form and occasionally damage runways on the lakebed. Land subsidence has occurred, resulting in differential vertical ground movement of approximately 1 m (3 ft) on the playa surface. (EAFB 1992)

3.1.1.9 Health and Safety

Both EAFB and DFRC have comprehensive occupational and flight safety programs intended to minimize the risk of injury or property damage. Operations must comply with OSHA requirements (Cal-OSHA where contractor personnel are utilized) as well as applicable Air Force, NASA, and local safety regulations. A project specific Health and Safety Plan approved by appropriate range officers would be required prior to the start of testing. (DFRC 1996, EAFB 1994-C)

The 412 Test Wing Range Safety Office ensures that safety is a priority during all range activities. AFFTC Instruction 11-1, Aircrew Operations, sets policies and defines procedures for aircrews operating aircraft at EAFB. This instruction addresses topics including ground and inflight procedures, traffic patterns, emergency procedures, and flight restrictions.

Fire protection on EAFB and DFRC is provided by the 95th Civil Engineering Group. Five fire stations serve the base. Medical care is provided by the EAFB hospital, which has a 15-bed capacity and provides both medical and dental services. DFRC maintains a medical dispensary for routine evaluations and emergency response operations. There are also three hospitals in Lancaster and one in Palmdale. (EAFB 1994-A)

Specific safety and health requirements for the X-33 Program will be developed by EAFB in conjunction with NASA and the X-33 Phase II Industry Partner. As a minimum, the X-33 Program can expect to submit preliminary and final site plans, safety standard operating procedures, a safety assessment report, and a missile flight safety operational plan. These documents will be prepared in accordance with EAFB, USAF, and DOD regulations.

3.1.1.10 Operational Noise

The major noise sources at EAFB and DFRC are vehicle traffic and aircraft operations, including fixed and rotary wing air traffic, engine testing and sonic booms. Noise level measurements are routinely performed to monitor conditions and provide a basis for corrective actions, if necessary. Noise descriptive information and units of measurement defintions and analogies can be found in Section 4.3.1.

Noise contours for 65 dBA and greater extend as far as 10 km (6.3 mi) from Runway 04/22 and lie completely within the boundary of EAFB. Parts of the on-base recreation areas lie between the 65 and 70 dBA contours. These areas include the EAFB Rod and Gun Club (Combat Arms Range), base golf course, off-highway vehicle area number 1, and some of the picnic areas and athletic fields. The Main Base residential area is outside the 65 dBA contour; however, two smaller residential areas separate from the main community lie between the 65 to 70 dBA and 70 to 75 dBA contours. The Main Base has a range of exposure from 65 to 85 dBA, the South Base 70 to 85 dBA. On-base land under the 80 dBA noise contours is primarily open space and test program support areas. The South Base and a portion of the Main Base are currently within the 80 dBA noise level; therefore, small areas of administrative, commercial, and industrial land are subject to these noise levels. The residential area and hospital are located outside the 80 dBA contours.

Areas off base that are within the 80 dBA noise contours are located to the north, west, and south-west of EAFB. Areas affected by the contour are primarily open space; however, the towns of Boron, Desert Lakes, North Edwards, and Rosamond are close to or within this contour. The Boron prison is approximately 0.8 km (0.5 mi) outside the 80 dBA contour. The area north of EAFB is primarily open space.

The area around PL is subject to very high levels of noise during rocket engine tests. Test firings occur during daytime hours for 1 to 3 minutes on an infrequent basis. Personnel at the test site remain in buildings designed to protect them from high noise levels. Testing of smaller engines is also conducted at this location, and noise levels are less than half those produced by the large Titan engines. Approximately 1,750 people reside within the 80 dBA contour of Titan test firings. Off-base land is primarily open space, with small industrial, residential, commercial, and public/ recreation areas.

EAFB and DFRC have had minimal environmental problems associated with noise as it relates to communities, population concentrations, or the public in general due to: the isolation achieved by their location in a remote and sparsely populated area of the Mojave Desert; the vast airspace available through DOD and Department of Transportation (DOT) to conduct flight research operations; and carefully planned air corridors within the proscribed airspace at altitudes and over geographic areas that successfully avoid populated communities. (EAFB 1992)

3.1.1.11 Transportation

Roadways

Primary off-base roads accessing EAFB are State Route (SR) 58 which crosses the northern edge of the base, SR 14 (Antelope Valley Freeway) and Sierra Highway which skirt the western edge of the base, and U.S. 395 which is on the eastern edge of the base. SR 58 connects the communities of Bakersfield, Tehachapi, Mojave, Boron, Kramer Junction, and Barstow. SR 14 and Sierra Highway connect the communities of Palmdale, Lancaster, Rosamond, and Mojave. U.S. 395 connects Victor Valley and Kramer Junction. A transportation map showing primary road and rail access is shown in Figure 3.1-3. It is projected that the portions of these highways near EAFB will continue to operate below capacity. (EAFB 1992)

Access onto public roads at the North Gate connects SR 58 with Rosamond Boulevard on the base. Rosamond Boulevard proceeds south through the Main Base then exits west, providing another access link at the West Gate to Sierra Highway and SR 14 in the town of Rosamond. From the south, 120th Street East/Lancaster Boulevard provides access to the base from the Lancaster/Palmdale area. (EAFB 1992)

Major EAFB roads include Lancaster Boulevard, Rosamond Boulevard, Mercury Road, Forbes Avenue, Mojave Boulevard, Fitzgerald Avenue, Wolfe Avenue, and Muroc Drive. Most on-base roads are two-lane roads made of asphalt with no curb or stormwater drainage system. Resurfacing has not occurred for most on-base roads for many decades, and the life expectancies of some roads have been exceeded. Engineering design has been performed to maintain/upgrade roads on EAFB, as necessary, and some upgrades have been completed. Repairs and upgrades will continue; however, this work does not need to be accelerated on behalf of the X-33 Program. (EAFB 1992)

On- and off-base roads typically operate at less than capacity (except for some intersections and base access gates) during peak hours. South and West access gates, as well as the intersection of Rosamond and South Muroc, experience delays during peak hour conditions. (EAFB 1992)

Transportation analysis for AF Plant 42 and vicinity includes the principal road network near the northern portion of the plant, access roads at 30th Street East and Avenue M (which runs east-west along the northern boundary of the plant), and two transportation alternative modes for moving the X-33 to EAFB. The proposed road transportation route for the X-33 is the same as the overland transportation route modified for NASA Space Shuttle Orbiters (JSC 1976). The route begins at Site 1 and continues through 10th Street East (a public road) to EAFB. Overhead power lines, telephone lines, and light poles were modified to provide clearance for the Space Shuttle. (EAFB 1992)

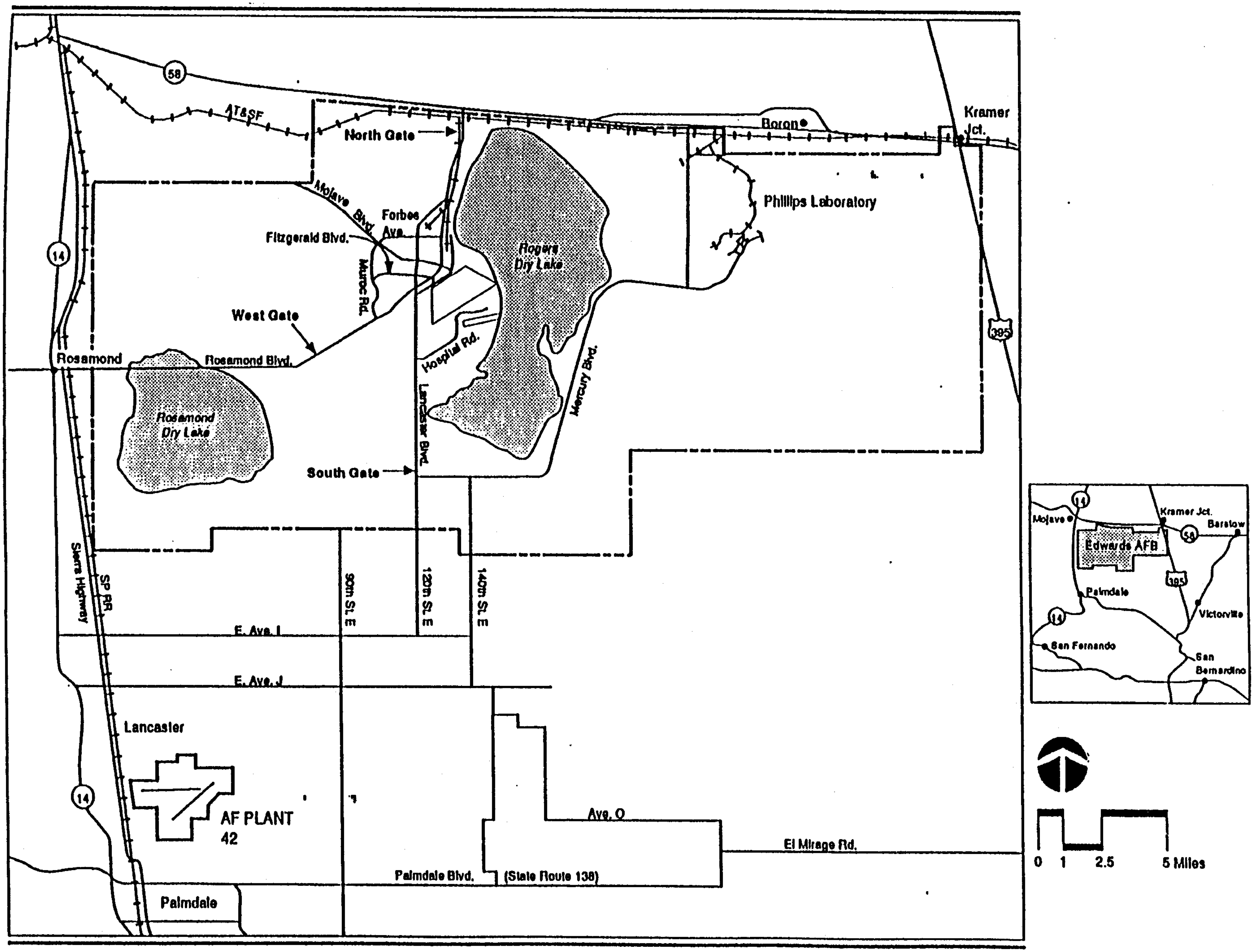


Figure 3.1-3. EAFB Transportation Map

Railroads

Railroad access to EAFB is from the Atchison Topeka and Santa Fe (AT&SF) railroad, which runs east-west north of the base boundary. Two railroad spurs from the AT&SF main line service separate portions of the base. The western spur follows Rosamond Boulevard into the Main Base and has two termination points: one at the Main Base and the other at several storage tanks west of the Main Base. A second spur connects the main line with the PL area, east of Rogers Dry Lake. In general, the rail spurs are in acceptable condition for use as light duty spurs. The western spur is currently used at least four times per year. (EAFB 1992-C). A Southern Pacific Railroad line runs parallel to the western boundary of EAFB, but does not serve the base. (EAFB 1994-B)

Airports

AF Plant 42 serves as the Palmdale Regional Airport under a Joint Use Agreement with the Los Angeles Department of Airports. Palmdale Regional Airport, comprising 22 ha (54 ac) of AF Plant 42, offers commercial air travel capabilities to Antelope Valley in addition to providing an alternative to Ontario and Los Angeles Airports. Flight activities are conducted on the same airfields used by Government contractors. (EAFB 1992)

Existing runways at AF Plant 42 and EAFB would be used for carrier aircraft return of the X-33 spaceplane. (EAFB 1992)

3.1.1.12 Population and Employment

The region of influence for EAFB is defined as the communities of Lancaster, Palmdale, Rosamond, Edwards/North Edwards, California City, Tehachapi, Mojave, and Boron. The population of this region is approximately 260,000 persons. The population of EAFB, which includes the daytime, on-base worker population and dependents living on the base, is approximately 21,000.

The local economy has experienced rapid employment growth during the past decade, with the greatest increases in the services, aerospace, and trade industries. The largest employer in the western Mojave Desert is EAFB. In 1990, professional and technical positions made up 44.6 percent of the total labor force in the region compared to only 15.7 percent for the nation. This percentage results from the fact that the aerospace industry is a primary business in the region. Most of the technology/aerospace firms in the area are located in the Palmdale and Lancaster areas. (EAFB 1992, EAFB 1994-A)

3.1.2 WSMR/WSTF

This section discusses the affected environment related to the proposed takeoff and landing sites on WSMR described in Section 2.3.3.2.

3.1.2.1 Facilities and Infrastructure

Wastewater Treatment

The domestic WWTP servicing the Main Post is located approximately 2.4 km (1.5 mi) southeast of the area. Influent wastewater flows range from 1.8 to 2.4 mLd (485,000 to 650,000 gpd). The WWTP currently operates at 50 percent capacity. The domestic wastewater collection system operates between 20 and 25 percent capacity during peak flow periods. (WSMR 1996-A)

The Stallion Range Center (SRC) area is served by a central domestic wastewater collection system that conveys sewage to a septic tank facility. Wastewater is then discharged into four oxidation ponds with a total volume of approximately 4.9 million L (1.3 million gal). Due to relatively low influent flows, the level of ponds is negligible, and full capacity has not been used. Existing capacity has been calculated to be approximately 34,000 Lpd (9,000 gpd). (WSMR 1996-A)

Wastewater on WSSH is captured, containerized and hauled to a treatment plant. WSTF domestic wastewater is treated through biological degradation and evaporation utilizing six lagoons. (WSMR 1996-A)

Electricity

Electricity at WSMR is primarily furnished via commercial power from El Paso Electric Company, with additional power provided by Otero County Electric Cooperative, Sierra Electric Cooperative, and Socorro Electric Cooperative. Socorro Electric Cooperative is the predominant service in the north range, whereas El Paso Electric Company serves the main WSMR and lower range areas. Each company has a distribution substation on WSMR. El Paso Electric Company owns, operates, and maintains distribution voltage facilities throughout WSMR and serves the majority of the south range area with 345- and 115-kV transmission lines and 14- and 24.9-kV distribution lines. WSMR Load Area #1 consists of six delivery points. The current load is 102,650,000 kWh. (WSMR 1994)

Approximately 300 diesel generators are available for use. They are all considered portable, although some are permanently stationed. Generators range in output capability from 10 to 700 kVA. (U.S. Army 1994-A). Both proposed takeoff sites have ready access to electrical power. (WSMR 1996-B)

Communications

The on-range telephone system consists of a loop from the Main Post to Stallion Gate, King I to Oscura Range, and Junction 9 to Rhodes Canyon. The loop is being upgraded from underground copper cables to fiberoptic carriers. (WSMR 1994)

Off-range telephone system infrastructure is entirely provided and maintained by U.S. West. U.S. West has a major fiberoptic inground system running from Las Cruces to Alamogordo along U.S. Highway 70. (WSMR 1994)

Air-to-ground communications consist of the following:

- Radio guidance and control for command and destruct, which is limited to 406- to 550-MHz frequency bands. Use of remote control units must be scheduled 30 days in advance.

- Air-to-ground (aircraft communications) using discrete frequencies within both VHF and UHF bands, specifically the 225- to 399.9-MHz range. (WSMR 1994)

Natural Gas

The majority of buildings in the Main Post area use natural gas, forced-air, heating systems. The Gas Company of New Mexico provides WSMR with natural gas through a pipeline consisting of two high pressure (6.2 MPa (900 psi)) pipes extending from El Paso, Texas, across Fort Bliss to Alamogordo, New Mexico. (WSMR 1994)

Fuel

There are 11 UST's and 19 AST's for storage of petroleum products located at the Main Post, Rhodes Canyon Range Center (RCRC) Station, SRC, High Energy Laser System Test Facility (HELSTF), and LC-38 containing unleaded gasoline and diesel fuel. Capacities of vehicle fuel storage tanks on WSMR range in size from 11,000 to 570,000 L (3,000 to 150,000 gal). Total capacity for petroleum storage at WSMR is 1.8 million L (478,000 gal). (WSMR 1994)

JP-8 fuel is the type of aviation fuel used at WSMR. Fuel is dispensed directly to aircraft from 210,000 L (55,000 gal) tanker delivery vehicles. No permanent storage tanks exist for this fuel. Permanent fuel tanks are owned by the USAF and located at Holloman AFB. (WSMR 1994)

Ready storage capability in portable tanks for LOX and LH_2 would be installed as required to support the X-33 Program. Permanent storage facilities consisting of a 250,000 L (65,000 gal) tank for LOX and a 250,000 L (65,000 gal) tank for LH_2 exist at WSTF. (WSMR 1996-B)

Hazardous Waste

WSMR has no permitted or active facilities for treatment or disposal of hazardous waste with the exception of sites for explosive destruction of munitions. Hazardous waste generated at WSMR is either disposed of or recycled at offsite facilities. WSTF has several permitted treatment facilities regulated under an approved RCRA Hazardous Waste Operating Permit which include an evaporation tank unit, waste fuel treatment unit, and open detonation unit. (WSMR 1994)

WSMR has established a Hazardous Materials Minimization Center. The Center is a single centralized storage, distribution and disposal facility for hazardous materials and hazardous waste. The facility is used by all WSMR personnel. Hazardous waste generated by the X-33 Program will pass through this facility for shipment offsite to appropriate treatment and disposal facilities.

Solid Waste

Three operating landfills serve WSMR. The Main Post landfill is located 11 km (7 mi) east of the Main Post. The second is located at SRC at the north end of WSMR, and the third is located near the High Energy Blast Facility on WSTF and is operated by NASA. WSMR has issued a Notice of Intent (NOI) to the state of New Mexico to continue operations while obtaining an operating permit. Solid waste is collected from Post Headquarters, offices, residences, and other buildings and transported to the Main Post landfill by WSMR's Ground and Surface Area Branch staff. Construction/demolition and yard wastes are transported to the site by private sector contractors and, to a lesser extent, by Ground and Surface Area Branch staff. The SRC landfill is operated by the Stallion Uprange Branch for disposal of solid and yard wastes generated in and around SRC. (WSMR 1994)

3.1.2.2 Air Quality

WSMR is located in New Mexico Air Quality Control Region (AQCR) 6. This region is in compliance with all National Ambient Air Quality Standards (NAAQS) for carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, PM_{10}, and lead. The 24-hour NAAQS for total suspended particulate matter has occasionally been exceeded. Exceedances are primarily attributable to dust storms characteristic of the windy spring months.

In addition to the Federal Standards, the state of New Mexico has set forth in Air Quality Control Regulation 201, ambient air quality standards that are as strict or more strict than NAAQS. In addition to protecting human health, the New Mexico standards are designed to protect against air pollution that injures animals and vegetation, corrodes building materials and works of art, reduces visibility, and generally diminishes the quality of life.

3.1.2.3 Airspace

WSMR controls 13 designated restricted airspace areas covering all of the range and some of the surrounding area. The restricted airspace is approximately 160 km long by 64 km wide (100 mi by 40 mi) (Figure 3.1-4). In most cases, controlled airspace can be scheduled for use from the surface to unlimited altitude 24 hours a day. Under a shared use agreement, some of the controlled airspace is turned over to the FAA for use by civilian aircraft during part of each day. (WSMR 1994)

The major restricted airspace activities are associated with research, development, testing and experimentation of military weapons systems, space vehicle components and tracking systems. Other missions include: operation of aerial drone targets; towed aerial targets; safety chase; aerial

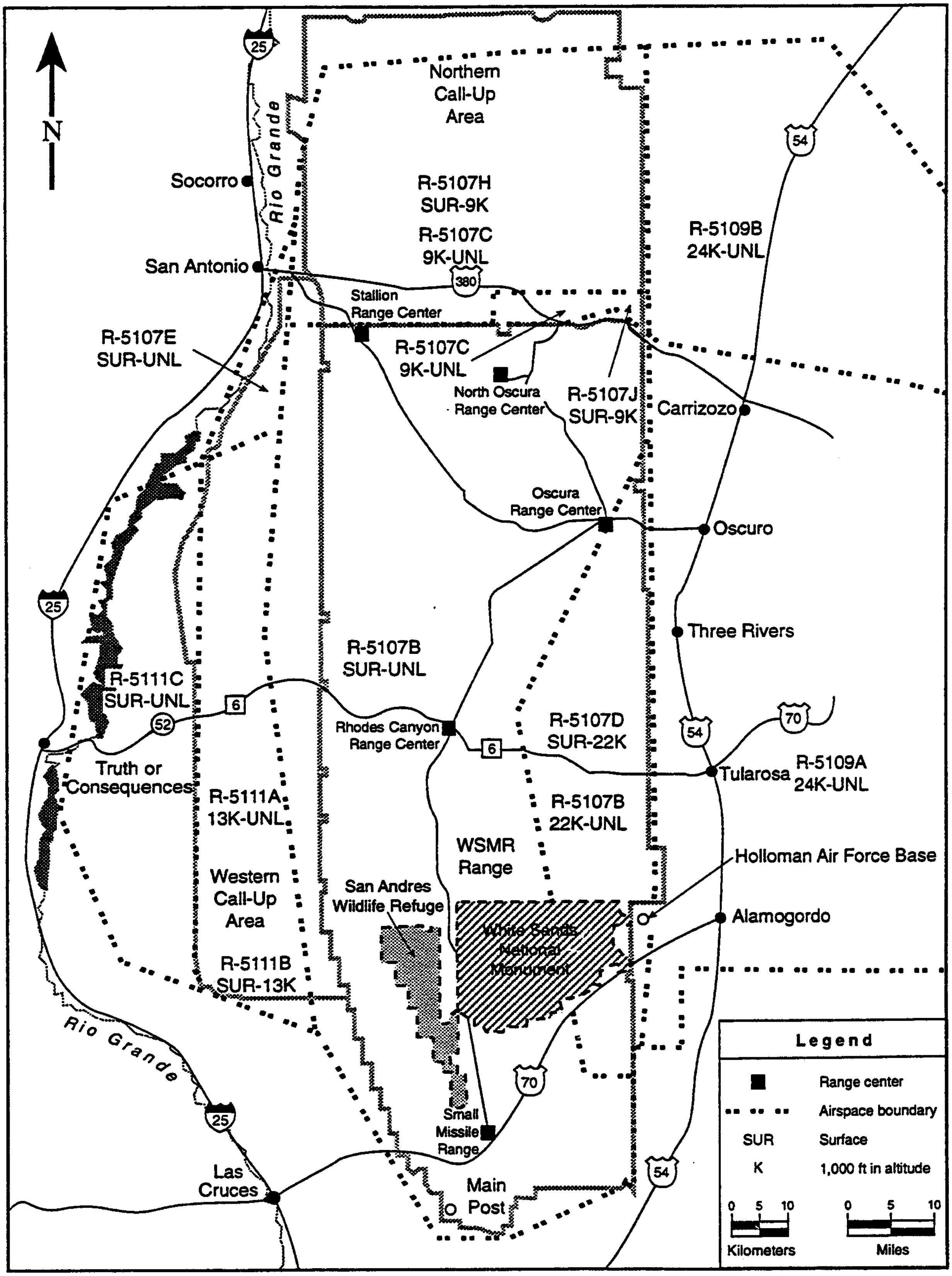


Figure 3.1-4. WSMR Restricted Airspace

photography; fixed and rotary wing security patrols; live air-to-air and air-to-ground gunnery; recovery of missiles, rockets, boosters, and aerial targets; and NASA and military aircraft training activities. (WSMR 1994)

Airport facilities that impact WSMR and surrounding airspace include: (WSMR 1994)

- Condron Airstrip on WSMR - approximately 4 takeoffs and landings per day
- Stallion Airstrip on WSMR - approximately 4 takeoffs and landings per week
- Oscura Airstrip on WSMR - approximately 6 takeoffs and landings per year
- WSSH Airstrip on WSMR - activity varies based on NASA needs
- Las Cruces International Airport 60 km (40 mi) southwest of WSMR - approximately 6 commercial flights daily plus general aviation activity
- Alamogordo/White Sands Regional Airport 6.4 km (4 mi) east of WSMR - approximately 25 takeoffs and landings per day
- El Paso International Airport 59 km (37 mi) south of WSMR - approximately 160 takeoffs and landings per day
- Holloman AFB adjacent to the western edge of WSMR - takeoffs and landings vary with operational requirements

3.1.2.4 Biological Resources

WSMR has a variety of vegetation and habitat types that support a diversity of wildlife. Habitats are widely dispersed and form a mosaic of scrubs, grasslands, savannas, woodlands, forests, and wetlands. These habitats are summarized along with relative coverages in Table 3.1-1. WSMR vegetation areas are shown in Figure 3.1-5. (WSMR 1994)

<u>Vegetation</u>

WSMR is located in south central New Mexico near the northern edge of the Chihuahuan Desert region. The relatively warm, dry climate is the primary factor influencing vegetation in the area. Most of the surface of WSMR is located on the floor of the Tularosa Basin and Jornado del Muerto in south central New Mexico where summer rainfall is low. Vegetation on these lowlands includes Chihuahuan desert scrub, closed-basin scrub, and desert grasslands. (WSMR 1994)

Rainfall increases and temperatures decreases with elevation in the Oscura and San Andreas Mountains. While soils, aspect, slope, and other factors play a role in determining the vegetation present at a given location, climatic effects of increasing elevation are the predominant environmental factors. At elevations above the desert scrub and grasslands regions, plains-mesa grasslands may occur. Grasslands and plains-mesa sand scrub are indicative of WSMR's location near the western edge of prairies that characterize the central portion of the United States. Both desert and plains-mesa grasslands form a broad savanna-like ecotone at higher elevations with coniferous woodlands dominating the cooler highlands of the Oscura and San Andreas Mountains.

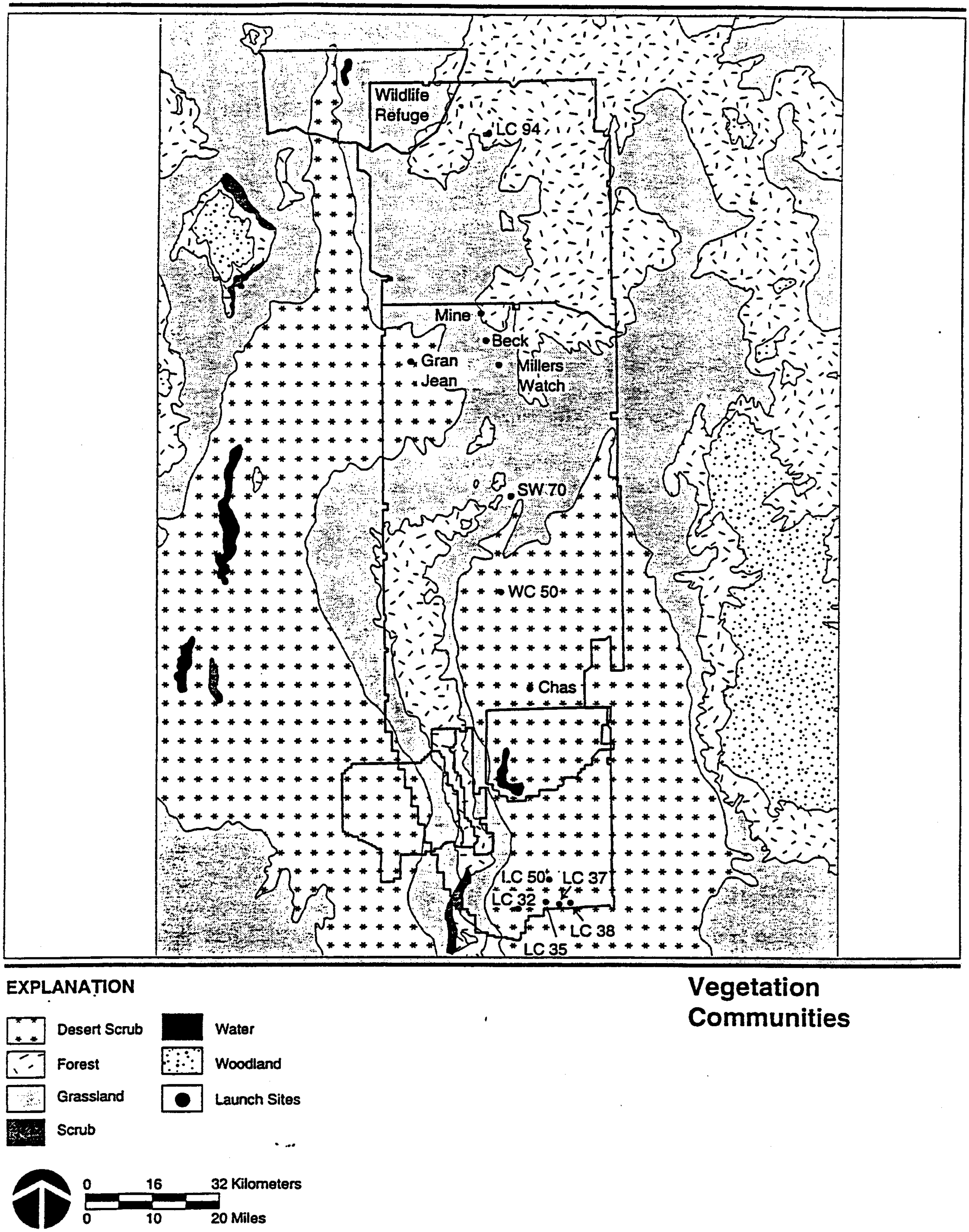


Figure 3.1-5. WSMR Vegetation Map

Junipers (*Juniperus* spp.) characterize the tree story of this transitional area. As slopes become steeper, the savanna develops a more woodland character and montane scrub vegetation forms part of the habitat mosaic. Gradually, pinyon pines (*Pinus edulis*) become more common until, near the summits of both mountain ranges, coniferous woodlands are dominated by pinyon. Montane scrub continues to be present into the highlands. On Salinas Peak, montane coniferous forest dominated by ponderosa pine (*Pinus ponderosa*) is present. (WSMR 1994)

Table 3.1-1. Vegetation Types Occurring on WSMR

Vegetation Type	Hectares (acres)
Coniferous Woodlands (Pinyon Pine Series)	
Pinyon Pine	11,200 (27,700)
Pinyon Pine and Mountain Mahogany	23,400 (57,800)
Savanna and Plains-mesa Grassland	91,200 (225,400)
Desert Grassland and Plains-mesa Sandscrub	174,000 (430,000)
Chihuahuan Desert Scrub	
Creosote Bush	222,000 (548,000)
Mesquite	114,600 (283,200)
Lava	16,900 (41,800)
Closed-basin Scrub	
Fourwing Saltbush and Tarbush	107,900 (266,600)
Arroyo Riparian and Wetlands	10,000 (24,700)
Barren Land	69,500 (171,700)
Dune Land	35,600 (88,000)

Notes:

Does not include 9,400 ha (23,200 ac) of WSMR, which New Mexico Natural Heritage Program (NMNHP) (1992) mapped as having no associated data.

The NMNHP (1992) provides no acreage for the lower montane coniferous forest vegetation.

Source: WSMR 1994

The WSMR LC-39 area consists primarily of mesquite dunes. Growing within the mesquite is four-wing saltbush, tansy mustard and an occasional soaptree yucca. In the interdune spaces, the most common plants are broom snakeweed, soaptree yucca and mesa dropseed. Other species occurring locally are sand sagebrush, sand bluestar, purple sand verbera, and Russian thistle. This type of vegetation has been classified as mesquite scrub. (WSMR 1996-A)

The proposed WSSH takeoff site is located on alkali flats. Vegetation is scarce because of the harsh environment resulting from alkaline soil conditions and susceptibility to flooding. The site consists of gypsum soils. The only vegetation known to occur in this type of land is sporadic iodine bush. Small quantities of picklewood, Indian ricegrass and salt cedar have been recorded in nearby areas. Overall, ground cover in the surrounding area has been estimated at less than 20 percent.

Wetlands and Floodplains

Extensive pockets of wetlands have been identified south of Route 6 and at the lower end of several canyons. Some of the other large areas of identified wetlands include Lake Lucero and Malpais Springs. Isolated springs and sinkholes and small wetland areas exist throughout the Tularosa Basin and Jornada del Muerto. Springs also occur in the San Andreas and Oscura mountains. Of the 67,706 ha (167,300 ac) of WSMR searched in the Geographic Information System (GIS) database, only 3,816 ha (9,430 ac) or 5 percent of the land surface was mapped as wetlands. (WSMR 1996)

Flooding on WSMR occurs infrequently, with the area of greatest concern being the Main Post. No floodplain maps or other information on flood prone areas is available. (WSMR 1996)

Wildlife

The primary wildlife species known to inhabit the WSMR LC-39 site is the Texas horned lizard (WSMR 1996-A). Wildlife is also scarce in the alkali flats of the WSSH site due to the extreme environment. No wildlife species are known to inhabit the takeoff site area (DOD 1992).

3.1.2.5 Threatened, Endangered, and Sensitive Species

Forty-four (44) state and federal listed threatened and endangered wildlife species, 38 sensitive plant species, and two sensitive habitat vegetation types occur or may occur on WSMR/WSTF. The only listed endangered plant species known to occur on WSMR is Todson's pennyroyal.

Federally listed endangered animal species include the interior least tern, northern Aplomado falcon, American peregrine falcon, and whooping crane. The bald eagle is federally threatened. Sensitive habitat includes black gamma/long leaf mormon tea and pinyon pine/scribner needlegrass. A complete listing of sensitive plant and animal species that occur or potentially occur on WSMR is provided in Appendix B. (WSMR 1994)

Identification of threatened and endangered species is controlled by USFWS, New Mexico Forestry Resource Conservation Division (NMFRCD), and New Mexico Department of Game and Fish (NMDGF) under the authority of the Endangered Species Act (Federal) and the Wildlife Conservation Act (State). WSMR's Environmental Services Division maintains information on these species and their specific locations (U.S. Army 1994-A). No threatened, endangered or sensitive plant or animal species are known to inhabit either of the proposed takeoff site areas. (DOD 1992; WSMR 1996-A)

3.1.2.6 Cultural Resources

Two NRHP sites are located within WSMR boundaries. Three New Mexico State Register of Cultural Properties sites are located in areas on or immediately adjacent to WSMR, one of which is also an NRHP site. (WSMR 1994)

Trinity Site National Historic Landmark, test site for the first atomic bomb, is located in the north-central portion of the range approximately 13 km (8 mi) southeast of SRC. It is both a National Historic Landmark and an NRHP property. The site encompasses 14,736 ha (36,480 ac) and includes Ground Zero (detonation site), various instrumentation bunkers, the McDonald Ranch, a nearby base camp, and "Jumbo," a huge steel vessel designed to enclose plutonium in the event of an unsuccessful test. (WSMR 1994)

LC-33 is a National Register site and a National Historic Landmark located 8 km (5 mi) east of the WSMR Main Post in the Nike Avenue launch complexes area. The U.S. Army blockhouse and gantry crane were used in the study and launch of V-2 and Viking rockets. The blockhouse was constructed in 1945 and was used as a laboratory for studying captured German V-2 rockets. (WSMR 1994)

In addition to military structures, historic ranches and homesteads are scattered throughout the missile range. Mining sites are located primarily in mountainous regions of the San Andreas, Oscura, and Jarilla ranges. The 241 historic sites identified on WSMR are distributed according to general type as follows: (1) homestead/ranch - 80 sites, (2) mining - 101 sites, (3) stage stops - 2 sites, and (4) other - 58 sites.

Two New Mexico State Register of Cultural Properties sites exist on WSMR. Mockingbird Gap is located approximately 0.4 km (0.25 mi) south of U.S. Highway 380, north of the Oscura Mountains. The White Sands National Monument (WSNM) Historic District and Parabolic Dune Hearth Mounds within the monument are located north of U.S. Highway 70, approximately 16 km (10 mi) west of Alamogordo, New Mexico. (WSMR 1994)

Mountainous regions in the northern portion of WSMR have been used as traditional religious sites by Native Americans. The Oscura Mountains are considered important to the Mescalero Apache tribe with prayer sites located throughout them. Salinas Peak in the San Andreas Mountains is considered important to the eastern Chiricahua Apaches. (WSMR 1994)

As of September 1993, archaeological surveys have been conducted on 6.7 percent or 59,500 ha (147,000 ac) of WSMR (WSMR 1994). Large cultural resource sites are known to occur on the border of the lakebed area near WSSH along Range Road 7. Cultural resources are also present along Range Road 10. WSSH is approximately 3 to 5 km (2 to 3 mi) north of the border of WSNM. There are no archeological resources on the proposed takeoff site. (DOD 1992)

No properties listed on the NRHP or the New Mexico State Register of Cultural Properties are located in the immediate vicinity of the WSMR LC-39 site. LC-33 is approximately 16 km

(10 mi) west. The proposed Rattlesnake Hill National Register Archeological District, consisting of 11 residential sites and 70 camp sites, is located approximately 10 km (6 mi) southeast on lands administered by the Bureau of Land Management (BLM). There are significant archeological resources in the WSMR LC-39 area. Some mitigation may be required, primarily through locating X-33 facilities in areas which do not impact any of the sites. (WSMR 1996-A/B)

3.1.2.7 Water Resources

Water supply sources are a critical concern at many WSMR installations. On-site sources of potable water principally involve localized groundwater sources. The current source of water for the Main Post originates from four watersheds. The water supply has a natural recharge of the potable water aquifer at 38 percent of annual withdrawal. Currently 11 wells serve the Main Post area with the capability to serve an effective population in excess of 14,400 people. Average daily usage in 1989 was 7.2 mLd (1.9 mgd) and daily peak usage was 14.7 mLd (3.9 mgd). The practical capacity of the Main Post wells is 32 mLd (8.4 mgd) based on a 16-hour pumping record. The Main Post area has a maximum storage capacity of 11.4 million L (3 million gal), which can support an effective population of 10,000 and an actual population of over 13,000. Well water is treated at the Main Post drinking water treatment facility. Treatment consists of sedimentation, disinfection, and fluoridation. (WSMR 1996-A)

At SRC, the primary source of water is groundwater. However, water must be treated prior to storage and distribution. Only one of the two wells is operational. Water storage consists of two 75,000 L (20,000 gal) tanks for untreated water, and one 380,000 L (100,000 gal) tank for treated water. The historical average consumption level is 36,300 Lpd (9,600 gpd) with a pumping capacity of 380,000 Lpd (100,000 gpd). SRC has a desalinization plant consisting of three 190,000 Lpd (50,000 gpd) ionics electrodialysis reversing systems. (WSMR 1996-A)

Water used at Oscura and RCRC is hauled by truck from existing water supplies. Buildings within these centers have their own storage tanks with domestic pressure systems. Water is hauled from existing sources to meet domestic and industrial water requirements at WSSH. (WSMR 1996-A)

Water at WSTF is supplied through two 305 m (1,000 ft) wells located west of the facility. Water is withdrawn from the Jornada aquifer through a permanent water withdrawal right with BLM. Wells are located within 7 km (4 mi) of WSTF boundaries, and water is pumped through transit pipes across land held under easement with BLM. Water is pumped approximately 10 km (6 mi) to a 3.8 million L (1 million gal) storage tank for distribution. Water is chlorinated at the WSTF facility. While 2,104 ha (5,200 ac) of water withdrawal rights apply, only 121 ha (300 ac) per year are presently being used. (WSMR 1994)

3.1.2.8 Geology and Soils

WSMR is located within the Mexican Highland section of the basin and range province. The area is characterized by alternating north-south aligned depressions and uplifted structural blocks (fault blocks). The eastern two-thirds of WSMR is located in the Tularosa Basin. The Sacramento and

Jarilla Mountains are located just east of the WSMR boundary. The western one-third of the base is occupied predominantly by the San Andreas Mountains, with the western slopes defining the western boundary. The Organ Mountains, a southern extension of the San Andreas Range, abut the southwest corner of WSMR. (WSMR 1994) Mountain ranges within WSMR and adjacent call-up areas vary from 6 to 48 km (4 to 30 mi) wide and up to 97 km (60 mi) long, with crests ranging from 1,980 to 2,740 m (6,500 to 9,000 ft). (WSMR 1994)

WSMR is located in the Rio Grande Rift, a region characterized by recent volcanism and active faulting. Rifting has resulted in continued movement along faults located at the boundaries of the Tularosa Basin and Jornada del Muerto. Three major fault zones occur partly within the boundaries of WSMR. The western Tularosa zone occurs along the eastern base of the San Andreas, Organ, and Franklin Mountains. Faults in this zone have moved during the late Pleistocene epoch (2 million to 8,000 years ago) and/or early Holocene epoch (within the last 8,000 years). The eastern Tularosa fault zone is identified by the Alamogordo fault located along the base of the Sacramento Mountains. Studies along this fault identify movement during the Pleistocene and possibly the Holocene eras. The third fault zone primarily comprises surface faults occurring within the Tularosa Basin east of the Organ Mountains. Movement along these faults has occurred within the last 2 million years and may be in response to activity along the major Tularosa fault zones. (WSMR 1994)

No major earthquake (greater than IV on the Modified Mercalli Intensity Scale) has occurred within the boundaries of WSMR, since historic recordkeeping began in 1849. Based on the young age of faults within WSMR and geologic records, a major earthquake at WSMR is a possibility. It is estimated that the largest earthquake that can reasonably be expected to occur at WSMR may result in displacements of 3 to 4 m (10 to 13 ft) along a fault length of 35 to 50 km (22 to 31 mi). The Rio Grande Rift system is still active, and there is evidence of faulting occurring as recently as 5,000 years ago. (WSMR 1994)

Potential geologic resources include gypsum, hydrocarbons, and minor amounts of a variety of minerals. Mining operations are not presently conducted within WSMR. However, previous mining activity in the WSMR area and neighboring mountains has been documented. As of 1978, there were 138,160 ha (341,388 ac) of state mineral rights, and the U.S. Congress previously set aside funds to purchase mining claims within WSMR. All but approximately nine claims have been purchased, and three are under lease. (WSMR 1994)

A soil survey identified 30 Soil Conservation Service (SCS) soil series, or soil units, covering the range area. Each soil series is characterized by differing composition, slope, texture of the surface layer and source material. Soils identified at WSMR include the gypsum dunes and lakebed deposits of WSNM and the Lake Lucero area, rocky soils associated with rough foothills and slopes of neighboring mountains, and the sandy loams of the Tularosa Basin and Jornada del Muerto. (WSMR 1994)

WSMR LC-39 is low dune land with loamy fine sand to fine sand soil. The topography is gently undulating to undulating between dunes. Water runoff is slow with low potential for water erosion. Wind erosion is high with actively blowing sand. Fertility and organic matter are low. (WSMR 1996-A)

Soil resources at WSSH are classified as gypsum land consisting of gypsum deposits overlying lacustrine sediments on broad level floors of a relic lake. The alkali soil results from a shallow water table and compacted gypsum soils with very low permeability. The soil typically has slopes less that 1 percent and is poorly drained. The soil has several limitations for shallow excavations because the water table is so high. Gypsum is about 0.3 m (1 ft) thick on the perimeter of the lakebed and more than 3 m (12 ft) thick near the center. The surface is level and smooth, and water may pond in low areas after it rains. (DOD 1992)

3.1.2.9 Health and Safety

Comprehensive health and safety programs and emergency response systems have been established at both WSMR (controlled by the U.S. Army) and WSTF (controlled by NASA). Ground operations on WSTF and WSSH are controlled by NASA and must comply with JSC's WSTF Safety Manual. Ground and flight safety on WSMR are controlled by the Army and must comply with Army and WSMR safety regulations. In addition, OSHA regulations (29 CFR 1910) must be complied with. Specific safety and health requirements for the X-33 Program would be developed by WSMR in conjunction with NASA and the X-33 Phase II Industry Partner. As a minimum, the X-33 Program can expect to submit preliminary and final site plans, safety standard operating procedures, a safety assessment report, and ground safety standard operating plans. These documents will be prepared in accordance with WSMR, Army, and DOD regulations. (WSMR 1994)

The WSMR Missile Flight Safety Office would ensure that flight plans meet range safety requirements, calculate the predicted flight hazard and dispersion areas using reasonably foreseeable performance anomalies and adverse wind conditions, and prepare the missile flight safety operational plan. (WSMR 1994)

WSMR and WSTF each have their own fire and emergency medical services. WSMR has a complete U.S. Army clinic capable of handling most medical emergencies. WSTF has a NASA-run medical clinic and ability to transport injured personnel to the hospital in Las Cruces, New Mexico. (DOD 1992)

3.1.2.10 Operational Noise

Airspace over WSMR is the primary environment containing the major noise sources on the range. Training activities include bomb delivery, Air Combat Command and Air National Guard air-to-air combat and supersonic flight tactics, and other military exercises. In addition, drone flights and tests of missiles, rockets, and space vehicles occur. Large areas of the airspace are used as safety buffer zones for missile and rocket firings. Ground systems and commercial systems are also tested and evaluated at WSMR. (WSMR 1994)

Noise levels at the Main Post area (the only range population center), the WSMR property boundary, and San Andreas National Wildlife Refuge (located approximately 19 km (12 mi) north of the Main Post area) have been estimated to be 55 to 65, 45 to 55, and 45 dBA, respectively. (WSMR 1994)

Generally, flight activities are at a high enough altitude and a low enough frequency to generate sound levels anticipated to be no greater than 70 dBA, which is the sound level of freeway traffic. Supersonic aircraft operations can generate sound pressure levels greater than 115 dBA. However, the average sonic boom noise level for existing activities was expected to be in the range of 50 to 60 dBA at distances varying from 8-16 km (5-10 mi) from the source. (WSMR 1994)

3.1.2.11 Transportation

Activities at WSMR require an extensive network of roadways, both on and off the range. The primary interstates serving the region are Interstate Highways 10 and 25. Interstate Highway 25 extends from Las Cruces beyond Albuquerque, to the north, with two lanes in each direction. It is in generally good condition. Interstate Highway 10 intersects Interstate Highway 25 at Las Cruces, New Mexico, and extends to Lordsburg, New Mexico, and beyond. It has two lanes in each direction and is in generally good condition. Other major roads serving WSMR include U.S.-designated Highways 54, 60, 70, 82, and 380. All are in good condition and adequately support current levels of traffic. (WSMR 1994)

There are seven primary access points to WSMR. U.S. Highway 70 provides direct access through the Small Missile Range gate and along Range Road 1 at the Las Cruces and El Paso gates. U.S. Highway 54 provides three access gates from local roads at Orogrande Range Camp (ORC), Tula gate in Tularosa, and ORC. U.S. Highway 380 provides access from Range Road 7 at SRC. Each of the seven access points has a gate supported by a guard house. Visitors and their vehicles are subject to inspections prior to entering the range. In addition to the main access points, there are approximately 87 entrances throughout the range which provide limited access and are protected by locked gates. (WSMR 1994)

As a safety precaution, an agreement with the state of New Mexico allows WSMR to establish off-range roadblocks on U.S. Highways 70 and 380. Under the agreement, a roadblock may last no longer than 1 hour 15 minutes. U.S. Highway 70 is subject to an average of approximately one roadblock per day. U.S. Highway 380 is subject to approximately one roadblock per month. WSMR also establishes an average of five internal roadblocks per day. Roadblocks can occur anywhere on the main range and are from 2.5 to 3 hours in length. (WSMR 1994)

The road network on WSMR is extensive and in an acceptable state of repair. Major roads are two lane roads that are paved, graded, and maintained as funding permits. They have the capacity to support 1,200 cars per hour per lane. (WSMR 1994)

Southern Pacific Railroad provides rail service to WSMR. Although there are no railroad tracks on WSMR itself, a railhead exists directly outside the gate at ORC. (WSMR 1994)

Figure 3.1-6 shows primary roads and rail lines on and around WSMR.

For information on air transportation at WSMR, refer to Section 3.1.2.3.

3.1.2.12 Population and Employment

The six county region of influence (ROI) can be characterized as generally rural, with approximately 74 percent of the 1990 census population (815,900) concentrated in the three largest communities: El Paso, Texas (515,300); Las Cruces, New Mexico (62,100); and Alamogordo, New Mexico (27,600). The ROI 1990 census population represented a 24.9 percent increase for the decade.

Total employment over the decade (1981 to 1990) for New Mexico and Texas has grown 25.7 and 20.4 percent, respectively. The six counties composing the ROI experienced a slightly larger increase, 26.4 percent for the decade.

The nonfarm component of employment increased at a rate approximately 2 percentage points greater than total employment over the decade for both New Mexico and Texas. Major non-farm employment sectors in the ROI are Government (33 percent), services (23 percent), and retail trade (17 percent). Farm employment, on the other hand, decreased 13.4 percent in New Mexico and 12.0 percent in Texas over the decade.

3.1.3 ER

This section discusses the affected environment related to takeoff and landing sites on the ER described in Section 2.3.3.3.

3.1.3.1 Facilities and Infrastructure

Approximately 30 percent of CCAS (about 19 sq km (7 sq mi)) is developed and consists of operational, support, and industrial facilities, the majority of which are concentrated either in the Industrial Area or along Launch Row, north/south of the Skid Strip. CCAS contains 36 launch complexes (7 are currently active), a turning basin for docking of submarines, an airstrip initially constructed for R&D in recovery operations for missile launches, and a small industrial area. Many hangars located on the station are used for missile assembly and testing. (CCAS 1994-A)

KSC occupies almost 560 sq km (about 216 sq mi), sharing a common boundary with the Merritt Island National Wildlife Refuge (MINWR). Approximately 5 percent of the land is developed. In addition to launch operations, KSC is home to a number of world class scientific and research facilities. These facilities include: the Launch Equipment Test Facility (LETF), Operations and Checkout (O&C) Building, Developmental Test Laboratory, Advanced Systems Development Laboratory, and Materials Science Laboratory. (SFA 1995)

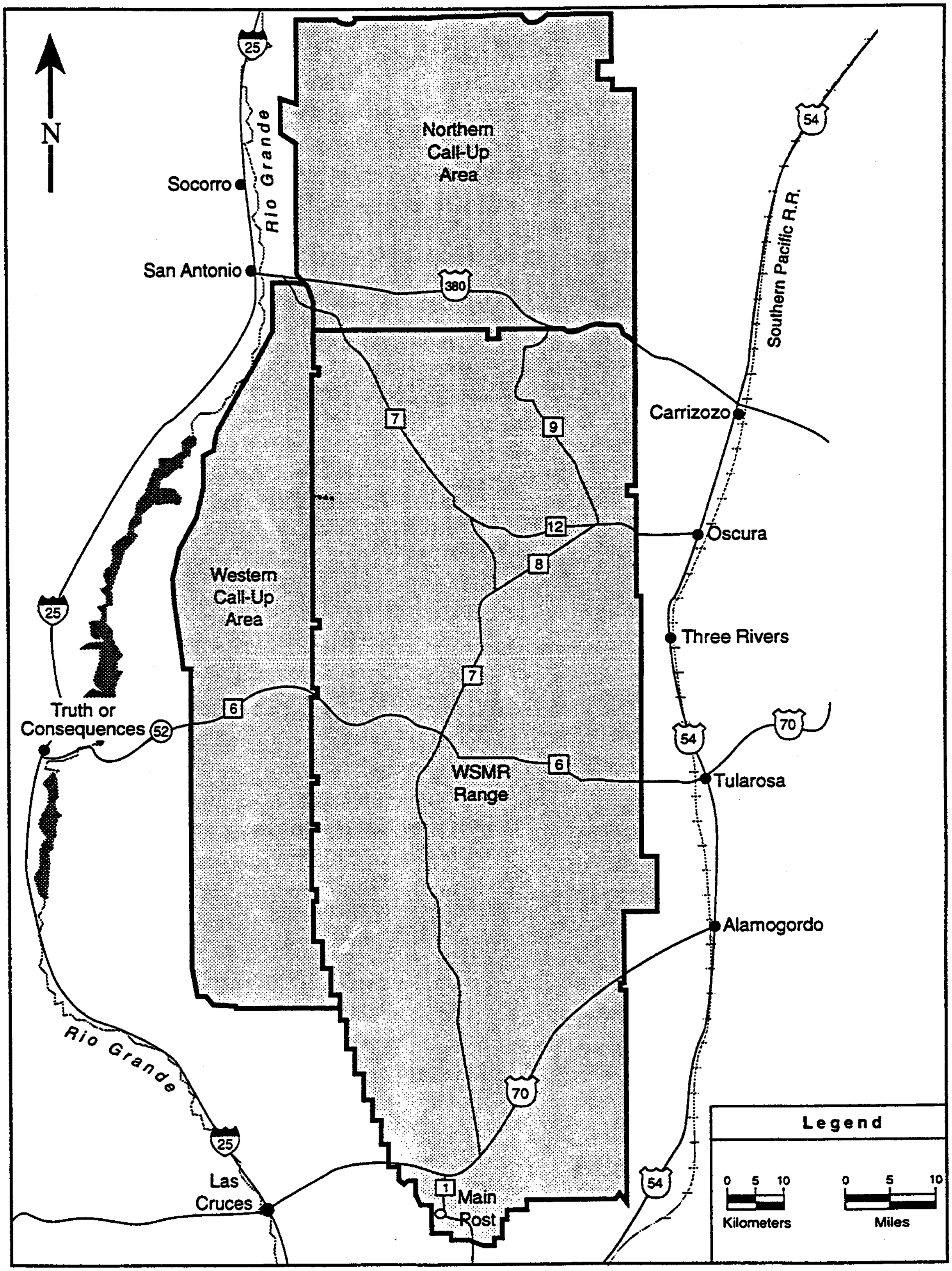


Figure 3.1-6. WSMR Transportation Map

Wastewater Treatment

CCAS treats both domestic and industrial wastewater on-site with 15 active WWTP's ranging in permitted capacity from 15,140 Lpd to 1.9 mLd (4,000 gpd to 0.5 mgd) and 109 septic tanks, each supporting isolated facilities and normally servicing less than 20 people. Maximum total flow from the 15 active WWTP's is 2.3 mLd (0.6 mgd). Design capacity of the main WWTP is 2.4 mLd (0.6 mgd) and permit capacity is 1.9 mLd (0.5 mgd). Process type is trickling filter, required treatment is secondary with basic disinfection, and effluent disposal is by percolation pond. Recorded data for average daily flow of wastewater in each WWTP indicates that flow is within permit capacity. The 30-year-old collection system includes approximately 35.4 km (22 mi) of sewer mains, 29 lift stations, and numerous manholes. The collection system, with upgrades for older lift stations, is adequate for another 20 years. A new consolidated wastewater treatment plant for CCAS is currently under construction and is scheduled to be completed in December 1996. The new WWTP will replace the old main WWTP and all package plants. Design capacity will be 3.1 mLd (0.8 mgd), providing a residual wastewater capacity of 0.8 mLd (0.2 mgd). The project includes collection lines, force mains, lift stations, and percolation ponds. It will have the capacity to handle deluge water, but the current plan is to continue discharging to grade after sampling and treating, if necessary.

KSC maintains operating permits for six wastewater treatment facilities. Two treatment plants, STP-1 and STP-4, located in the Industrial Area and VAB Area, respectively, provide service for approximately 80 percent of NASA and contractor personnel at KSC. STP-1 has a design capacity of approximately 1.4 mLd (0.4 mgd) and is operating at approximately 31 percent capacity. STP-4 has a design capacity of 0.8 mLd (0.2 mgd) and is operating at approximately 50 percent capacity. STP-10 services Spaceport USA. It has a design capacity of 0.4 mLd (0.1 mgd) and is operating at approximately 38 percent capacity. STP-15 has been converted to a grease treatment plant. The remaining permitted treatment facilities are small package plants which service outlying facilities and operational areas. In addition to state permitted facilities, a number of septic tank systems throughout KSC support small offices or temporary facilities. (KSC 1994-B, JPL 1995, CCAS 1991, CCAS 1994-A)

Electricity

Power distribution systems for the ER have a total capacity of 137,000 kVA. Florida Power and Light (FPL) provides power through high voltage, nominal 115 kV or 138 kV transmission lines from its 800-megawatt, oil-burning power plant located in Port St. John. Transformers at three main CCAS substations convert transmission voltage to distribution voltage, nominally 13.2 kV. Two transformers have capacities of 20 megavolt-amperes and the other has 15 MVA. About 170 smaller substations convert distribution voltage to user voltages. Of the total 467 km (290 mi) of primary and secondary distribution lines at CCAS, 193 km (120 mi) are overhead and 274 km (170 mi) are underground. A power generation plant was built in 1953, but has not generated power for approximately 20 years. A standby power generation plant is under construction, which will supply 4.5 megawatts (MW) to the existing critical loop. KSC distributes 13.2 or 13.8 kV to individual substations or transformers at various facilities from one of two main substations. KSC also has a 5.0 MW emergency power generation plant which provides power to critical loads in the KSC LC-39 area in case of commercial power loss. Expansion of this plant to 10 MW is planned. The expansion should occur in 1998. (USAF 1996, KSC 1992-A)

Communications

KSC communication systems provide: conventional telephone service; transmission of large volumes of test data to central collection or reduction stations; transmission of timing information from operations centers to data gathering instrumentation at widely scattered locations; transmission of weather and range safety data; and communications with satellites, Space Shuttles, and other hardware in space. CCAS, with its numerous communications control centers, is the "hub" for all communications activities on the ER. Systems include point-to-point, air-to-ground, ship-to-shore, intrastation, interstation, and world-wide communications in support of the 45 SW and indirectly to NASA. All communication lines are underground at KSC and CCAS. Several television broadcasting companies have constructed facilities supporting launch broadcasting: ABC, CBS, CNN, and NBC. Radio broadcasters and wire services have installed trailer offices at the KSC press site, including: AP, AFP, Reuters, UPI, VOA, and Westwood One. (KSC 1992-A, CCAS 1994-C, USAF 1996)

Natural Gas

Natural gas is used at KSC primarily for facility heating, but also for cafeteria equipment and vehicles. City Gas Company provides natural gas at 2,068 kPa (300 psi) from a 30.5 cm (12 in) steel line along NASA Causeway and Kennedy Parkway. Branches off the main pipeline vary in size, 5 to 20 cm (2 to 8 in), and construction is steel or plastic. Extension of the pipeline eastward along NASA Causeway to service CCAS is expected in the 1996-1997 timeframe. (KSC 1996-E)

Fuel

CCAS has 116 AST's and 21 UST's for petroleum storage. Forty-four (44) are regulated and range in volume from 2,100 to 106,000 L (550 to 28,000 gal). Ninety-three (93) are unregulated and range in volume from 189 to 61,000 L (50 to 16,000 gal). There are 80 existing nonpetroleum tanks ranging in volume from 757 to 379,000 L (200 to 100,000 gal). JP-5 jet fuel is stored at CCAS, and additional jet fuel is stored at PAFB. Capacities are unknown at this time. Five AST's ranging in capacity from 37,854 L to 107,884 L (10,000 gal to 28,500 gal) are used to store LOX (total storage capacity 395,576 L (104,500 gal)). Five AST's ranging in capacity from 92,743 L to 105,992 L (24,500 gal to 28,000 gal) are used to store LH_2 (total storage capacity 503,460 L (133,000 gal)).

At KSC, number 2 diesel fuel is delivered in bulk via tanker trucks from local vendors. Primary storage is four large AST's located in the KSC LC-39 area. Three of the tanks have a capacity of 117,350 L (31,000 gal) each; the remaining one has a capacity of 37,900 L (10,000 gal). Tanks are topped off approximately every 3 weeks. Fuel is dispensed directly to the Utility Annex and to mobile equipment via two refueling trucks. An AST at the Generator Shop stores 2,100 L (550 gal) of diesel fuel. A 30,300 L (8,000 gal) UST located at the Heavy Equipment Maintenance Facility is used for mobile equipment and refueling trucks. A 1,900 L (500 gal) storage tank at KARS Park 1 stores number 2 diesel fuel for landscape and facility maintenance equipment. The heat plant has been converted to natural gas, but two storage tanks provide diesel fuel as a backup to the natural gas. Storage capacities are 56,800 and 674,000 L (15,000 and 178,000 gal). Other UST diesel storage tank capacities include: 37,900 L (10,000 gal) at the emergency power station; 11,000 L (3,000 gal) at the propellants lab; 600 L (150 gal) at the weather tower; and 75,700 L (20,000 gal) at the motor pool.

Unleaded gasoline (used for transportation and lawn maintenance equipment) is stored in a 30,300 L (8,000 gal) UST at the Heavy Equipment Maintenance Facility in the KSC Industrial Area. A 1,900 L (500 gal) tank at KARS Park 1 stores unleaded gasoline for landscape and facility maintenance equipment. Other unleaded gasoline storage tanks include: 2,100 L (550 gal) AST at the Generator Shop; 75,700 L (20,000 gal) UST at the motor pool; and 45,400 L (12,000 gal) UST at the VAB. Diesel fuel and unleaded gasoline dedicated to motor vehicles are delivered to KSC via tanker truck, 32,000 L (8,500 gal) at a time.

A Compressed Natural Gas (CNG) fueling station in the Industrial Area is dedicated to motor vehicles. Three storage cylinders are on-site, with a capacity of approximately 900 L (240 gal). City Gas Company of Florida maintains the pipeline for the CNG.

A summary of KSC's total fuel storage capacity is provided in Table 3.1-2.

Table 3.1-2. KSC's Approximate Total Fuel Storage Capacity

Type Fuel	AST		UST		Tankers		Total Capacity (L)
	No. of Tanks	Subtotal Capacity (L)	No. of Tanks	Subtotal Capacity (L)	No. of Tankers	Subtotal Capacity (L)	
Diesel fuel	53	1,670,000	18	367,753	0	0	2,040,000
Regular gasoline	2	3,790	2	416	0	0	4,200
Unleaded gasoline	1	1,890	6	265,000	0	0	267,000
JP-5	5	379,000	0	0	5	92,400	471,000
Fuel Oil	3	8,710	0	0	0	0	8,710
LOX	8	7,160,000	0	0	10	151,000	7,310,000
LH_2	6	6,970,000	0	0	4	197,000	7,160,000

Source: KSC 1996-C and KSC 1996-D

<u>Hazardous Waste Management</u>

CCAS operates waste management under the 45 SW OPlan 19-14, Petroleum Products and Hazardous Waste Management Plan. Five main entities are involved in hazardous waste management and disposal for CCAS: the generator of the waste, NASA's Joint Propellants

Contractor (JPC), Launch Base Support Contractor (LBSC) for CCAS, DOD's Defense Reutilization and Marketing Office, and 45 SW Environmental Planning Function at PAFB (45 CES/CEV). CCAS operates five hazardous waste storage facilities permitted for ignitable and toxic wastes, halogenated solvents, used batteries, and spent sodium lamps. Maximum storage capacity is 41,600 L (200 55-gal drums (11,000 gal)). The station operates at an average capacity of 50 percent, managing approximately 181,000 kg (400,000 lb) of various regulated substances annually. Three of the storage facilities are planned to be closed over the next 2 years. CCAS has a secondary containment capacity of 20,000 L (5,300 gal). A permitted Explosives Ordnance Disposal (EOD) facility also exists on-site for treating reactive hazardous waste. CCAS generated 186,700 kg (411,700 lb) of hazardous waste in 1992, of which over 27,350 kg (60,300 lb) was recoverable or marketable as excess. (CCAS 1994-A, CCAS 1996-B)

Control of hazardous waste at KSC is assigned to the Waste Management Authority (WMA). KSC has a Florida Department of Environmental Protection (FDEP) operating permit for storage, treatment and disposal of hazardous waste. Two facilities operate under this permit. The Hazardous Waste Storage Facility at KSC LC-39 has a maximum capacity of 225,700 L (59,600 gal), and the facility at the hypergol area has a maximum capacity of 208,000 L (55,000 gal). The facility at the hypergol area is scheduled to be closed by the end of 1996. At that time, the storage facility at KSC LC-39 will receive all hazardous waste generated at KSC. KSC operates at approximately 30 percent of design capacity. (KSC 1994)

Solid Waste

CCAS's landfill is permitted for construction/demolition debris and asbestos only. General solid refuse is collected by private contractor and disposed off-station at the Brevard County Landfill. Of the 74 ha (182 ac) at the CCAS landfill, 4.2 ha (10.4 ac) are in operation and 45.8 ha (113.2 ac) remain available for use. The remainder of the landfill is closed. CCAS generated 2,609,000 kg (2,900 tons) of solid waste and 695,800 kg (767 tons) of recyclable solid waste in 1992. (CCAS 1994-A, CCAS 1996-B)

Solid nonhazardous waste management at KSC is accomplished by landfill and recycling facilities. The new 16 ha (39 ac) Class III landfill is permitted to receive between 16,330 and 63,500 kg (18 and 70 tons) of waste per day. Average daily accumulation is 20,000 kg (22 tons) per day.

3.1.3.2 Air Quality

The ER is located within an attainment area with respect to NAAQS for criteria pollutants. CCAS has been issued four air emission permits by FDEP covering various sources (e.g., boilers generating over 1 million British thermal units (Btu's), paint booths, fuel handling systems, and fugitive volatile organic compounds (VOC's). KSC has five area-wide FDEP operating permits covering all emission points on the center.

Ambient air quality at the ER is influenced by NASA and DOD operations, land management practices, vehicle traffic, and emission sources outside the range. Air quality is also influenced by emissions from two regional power plants located within a 16 km (10 mi) radius of the range. Space launches, training fires, and fuel load reduction burns influence air quality as episodic events.

Ambient air quality is monitored by Permanent Air Monitoring System (PAMS) stations. Continuous analyzers monitor SO_2, NO_2, CO, O_3, and PM_{10}. Instruments in meteorological towers monitor wind speed, wind direction, high and low temperature, and relative humidity.

NO_2 and SO_2 emissions are related to utilized fuel combustion and mobile sources. A strong correlation between elevated NO_2 and SO_2 levels and prevailing westerly winds indicate that power plants to the west of the ER are the primary source of these emissions.

O_3 is the most consistently elevated criteria pollutant at the ER. Local sources, as well as distant metropolitan areas, can contribute to elevated ozone levels. Ozone precursors generated over land are directed offshore by prevailing evening winds. Morning sunlight catalyzes the conversion to ozone and onshore breezes can return ozone to the land mass. Six exceedances of ambient air quality standards for O_3 have been recorded at KSC since 1988.

3.1.3.3 Airspace

The ER has a number of restricted and warning areas associated with space launch and Space Shuttle recovery operations (Figure 3.1-7). For Space Shuttle landing training, other specific areas are controlled to prevent interference from intruding aircraft. In addition, Notices to Airmen (NOTAM's) are issued as required for rocket stage impact areas and impacts predicted in remote areas—such as the Indian and Pacific Oceans—where appropriate authorities are notified. A summary of restricted and warning areas follows.

R-2932, R-2933, and R-2934 cover airspace immediately over CCAS and KSC. Airspace is controlled from the surface to unlimited altitude in steps from ground to 1,500 m (5,000 ft); 1,500 to 4,600 m (5,000 to 15,000 ft); and to unlimited altitude. Below 1,500 m (5,000 ft) in the area of the CCAS Skid Strip, the restricted area is continuously activated, and above 1,500 m (5,000 ft), it is activated by NOTAM 24 hours in advance. Aircraft transiting these areas must be in contact with PAFB Approach Control.

R-2931 is a circle 3,700 m (12,000 ft) in radius which lies under R-2934. It covers airspace from ground to 4,600 m (15,000 ft) and is activated by NOTAM 24 hours in advance.

R-2935 overlies CCAS and KSC as well as some of the surrounding areas. It begins at 3,350 m (11,000 ft) and goes to unlimited altitude. It'is activated by NOTAM 24 hours in advance.

W-497A and W-497B begin where R-2932, R-2933, and R-2934 end just off the CCAS and KSC shorelines and continue out approximately 111,100 m (364,600 ft). They control altitude from surface to unlimited and are activated by NOTAM. When not activated, airspace is controlled by the Miami Center.

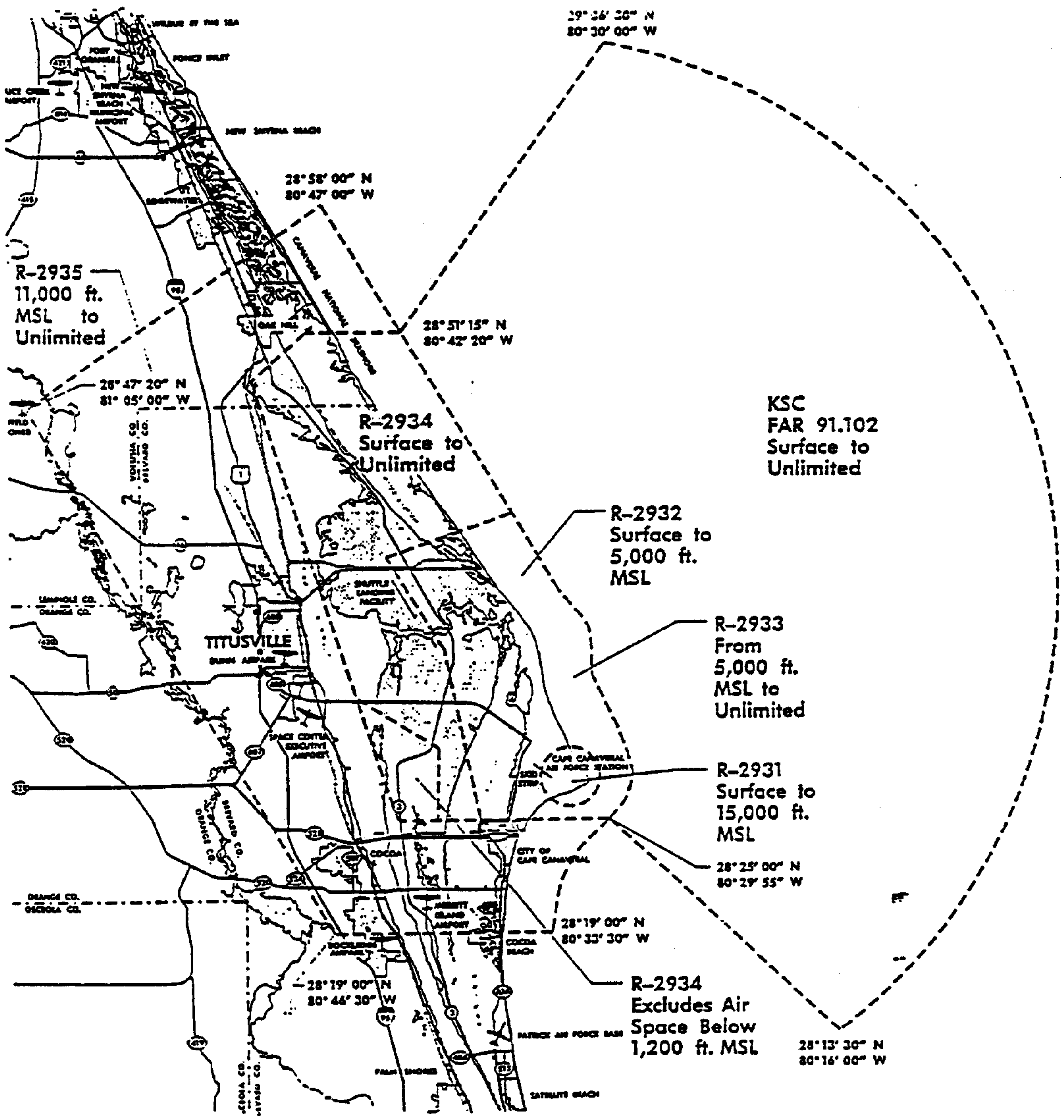


Figure 3.1-7. KSC and CCAS Restricted Airspace

FAR 91.143 airspace covers an area approximately 50,000 m (164,000 ft) offshore in an expanding arc from the edges of R-2932, R-2933, and R-2934 restricted areas. Altitude is surface to unlimited. It is activated by NOTAM 3 hours before Space Shuttle launch and 3.5 hours before Space Shuttle landing.

NASA-A, NASA-B, and NASA-C are airspace reserved for Space Shuttle landing training. NASA-A overlies CCAS and KSC, plus areas to approximately 9,260 m (30,400 ft) south of R-2932, R-2933, and R-2934 and covers surface to 13,700 m (45,000 ft). NASA-B covers an area similar to R-2935 from 4,600 to 13,700 m (15,000 to 45,000 ft). NASA-C covers an area offshore and directly east of NASA-A from surface to 13,700 m (45,000 ft). The three areas are activated as required to support NASA Space Shuttle landing training at the SLF.

The most common type of operation supported by ER requiring airspace activation are space launches originating from CCAS and KSC. R-2932, R-2933, and R-2934 restricted areas typically are activated a few hours before launch for a period covering the launch window plus a short period after the window closes. Air traffic not directly involved in supporting the launch is kept out of restricted areas. For Space Shuttle launches, R-2935 is also activated to enable emergency recovery of the Space Shuttle Orbiter should it become necessary.

Vehicles launched from CCAS and KSC leave restricted and warning areas and are monitored during flight, including taking action to destroy the vehicles should it become necessary. Once beyond the restricted areas, vehicles generally operate at altitudes which eliminate concerns over clearance from other air traffic; they are far above any other aircraft.

Safety concerns define primary restrictions on operations within restricted and warning areas, as well as the ER in general. The normal ER launch azimuth limits are 37 degrees to 114 degrees, although allowable flight plans are defined primarily by safety risk analyses. These safety analyses define the acceptability of a given mission profile, which may result in restrictions not only on azimuth, but also on the loft angle of the trajectory as well. The ER does not normally place restrictions on airspeeds or mach numbers.

See Section 3.1.3.11 for a description of area airports.

3.1.3.4 Biological Resources

<u>Vegetation</u>

CCAS encompasses approximately 6,900 ha (17,200 ac) of land, including approximately 21 km (13 mi) of shoreline along the Atlantic Ocean and 19.6 km (12.2 mi) along the Banana River. The majority of the complex consists of vegetation indigenous to Florida coastal scrub (2,800 ha (7,000 ac)), coastal strand (378 ha (933 ac)), and coastal dune (263 ha (650 ac)) plant communities. Wetlands at CCAS include approximately 486 ha (1200 ac) of freshwater wetlands, 125 ha (310 ac) of mangrove swamp, 76 ha (189 ac) of salt marsh, and 647 ha (1600 ac) brackish impoundments. Hammocks at CCAS are small in size, totaling less than 40 ha (100 ac). Aquatic marine habitats include ponds/borrow pits (21 ha (52 ac)), canals (25 ha (63 ac)), brackish water (40 ha (100 ac)), and saltwater (647 ha (1,600 ac)). Launch and support facilities cover most of the remaining hectares. Coastal scrub is characterized by dense growths of scrub vegetation, such as myrtle oak (*Quercus myrtifolia*), live oak (*Q. virginiana*), saw palmetto (*Serenoa repens*), and Chapman oak (*Q. chapmanii*).

Upland vegetation communities that could be affected by the X-33 Program are coastal strand and coastal scrub, which are dominated by sea oats, saw palmetto, myrtle oak, and sand live oak *(Quercus geminata)*.

Community types at KSC are listed in Table 3.1-3. Vegetation maps for SLC-37 and KSC LC-39 are provided in Figures 3.1-8 and 3.1-9.

<u>Wetlands and Floodplains</u>

Wetlands are found in the central part of Merritt Island where they occur mainly in interdunal swales within scrub or slash pine *(Pinus elliottii)* flatwoods communities or along drainageways. Wetlands also occur on the edges of Merritt Island between uplands and lagoonal systems, Banana River, Banana Creek, Indian River, and Mosquito Lagoon. Wetland vegetation includes: swamp, savanna, marsh, sand cordgrass-black rush, saltwort-glasswort *(Batis maritima, Salicornia virginica)*, saltmarsh cordgrass *(Spartina alterniflora)*, and mangrove communities. The areas are dominated by red maple *(Acer rubrum)*, elm *(Ulmus americana)*, Carolina willow *(Salix caroliniana)*, beardgrass *(Andropogon* spp.), sand cordgrass *(Spartina bakeri)*, southern *(Typha domingensis)* and common *(Typha latifolia)* cattail, cabbage palm, black rush *(Juncus roemerianus)*, saltgrass *(Distichlis spicata)*, sea oxeye *(Borrichia frutescens)*, buttonwood *(Conocarpus erecta)*, and black *(Avicennia germinans)*, white *(Laguncularia racemosa)*, and red *(Rhizophora mangle)* mangrove. Many wetlands within MINWR provide habitat for approximately 200,000 waterfowl, including great blue herons, egrets, wood storks *(Mycteria americana)*, cormorants, and brown pelicans *(Pelecanus occidentalis caroliensis)*.

The Federal Emergency Management Agency has established both 100 year and 500 year floodplains for KSC and CCAS. Neither the SLC-37 nor the LC-39 launch site is located in either of these floodplains.

<u>Wildlife</u>

Coastal scrub and coastal woodland provide excellent cover for wildlife species such as the white-tailed deer, armadillo, southeastern beach mouse *(Peromyscus polionotus niveiventris)*, bobcat *(Lynx rufus)*, feral hog, Florida mouse *(Peromyscus floridana)*, raccoon, rabbit, gopher tortoise *(Gopherus polyphemus)*, and numerous bird, lizard, and snake species. Coastal strand is composed of a thicket of dense woody shrubs and includes species of cabbage palm (*Sabal palmetto*), saw palmetto, and tough buckthorn (*Bumelia tenax*). Coastal dunes consist mainly of sea oats *(Uniola paniculata)*, which has been listed as a State Species of Special Concern. (CCAS 1994-A, CCAS 1994-D)

Table 3.1-3. Enumeration of Community Types Comprising Total Area at KSC

Community Type	Area (Acres)
Coastal Dunes	368
Coastal Strand	630
Sand Pine	2
Mixed Oak/Saw Palmetto	16,084
Coastal Live Oak Woods	323
Slash Pine Flatwoods	8,745
Live Oak/Cabbage Palm Hammock	2,039
Red Bay/Laurel Oak/Live Oak	3,128
Cabbage Palm Hammock	1,775
Southern Red Cedar/Live Oak Hammocks	181
Saltmarsh Cordgrass	56
Black Mangrove	2,641
Saltwort/Glasswort	621
Black Mangrove/Saltwort/Glasswort	100
Mixed Salt-Tolerant Grasses Marsh	2350
White Mangrove/Mixed Mangrove	1,198
Sea Oxeye	298
Mud Flats	283
Willow Swamp	1,797
Hardwood Swamp	1,095
Mixed Grass/Sedge	110
Cattail Marsh	33,652
Graminoid Marsh	10,436
Cabbage Palm Savanna	5,385
Wax Myrtle/Brazilian Pepper	1,318
Australian Pine	465
Southern Red Cedar Thicket	88
Shrub/Herbaceous Spoil Vegetation	265
Citrus	2,688
Mixed Oak/Saw Palmetto Disturbed	1,119
Dikes	2316
Dead Mangrove	201
Ruderal	2,938
Beach/Bare Ground	429
Oceanic	0
Open Lagoonal and Associated	22,485
Impounded Waters	8,837
Inland Waters	209
Landfill Ditches, Borrow Pit	523
Transportation	2,333
Cultural Features	485
TOTAL	**140,000**

Source: KSC 1994

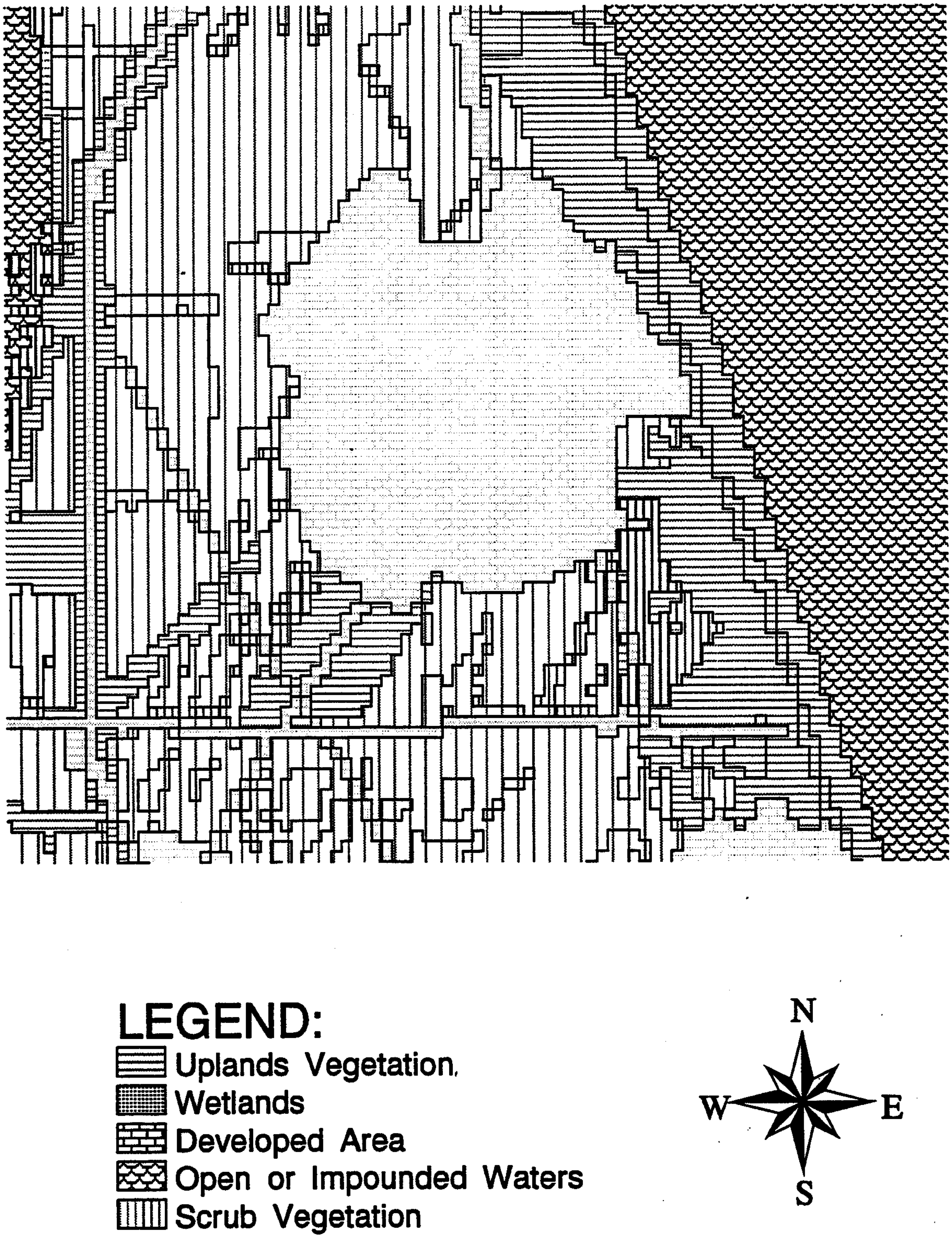


Figure 3.1-8. CCAS SLC-37 Area Vegetation Map

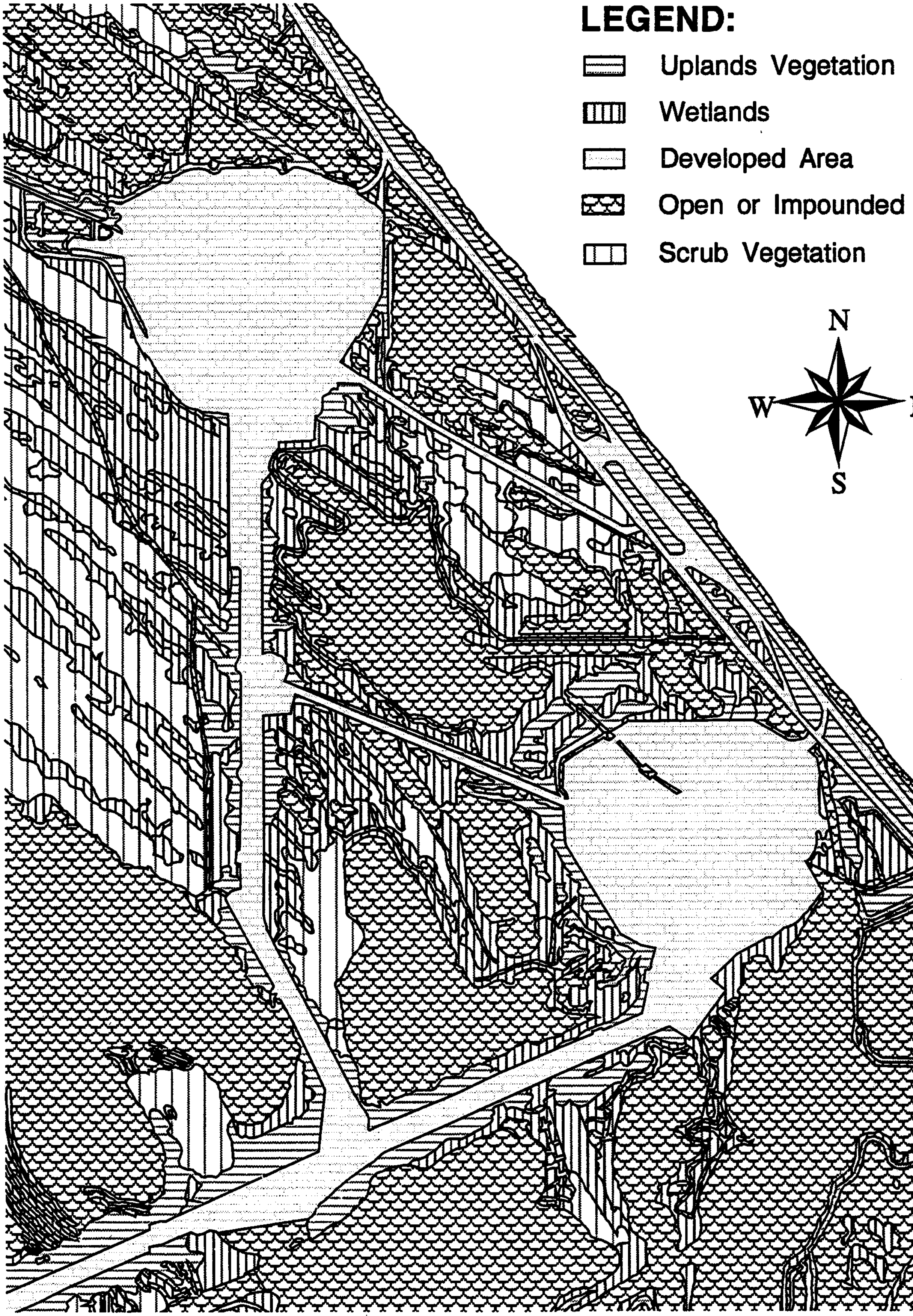


Figure 3.1-9. KSC LC-39 Area Vegetation Map

Over 53,800 ha (133,000 ac) of KSC property are managed as a refuge by USFWS and the National Park Service (NPS). USFWS operates and maintains MINWR, which shares a common boundary with KSC. The refuge was organized in 1972 as a buffer zone for wildlife preservation. NPS operates and maintains the Canaveral National Seashore (CNS), which was established in

1975 to ensure preservation of the least disturbed and undeveloped coastal segment remaining along Florida's eastern shoreline. USFWS and NPS maintain the large and diverse communities of flora and fauna at KSC.

Uplands provide important habitat for many bird species, including the threatened Florida scrub jay *(Aphelcoma coerulescens coerulescens)*. Pileated woodpeckers, gray squirrels, armadillos, and migratory warblers are also common residents of these areas.

The Indian River Lagoon system has nearly 150 species of fish. Lagoons and rivers support commercial fishery operations for both shellfish and fin fish, including blue crabs, shrimp, clams, and mullet. Offshore, the KSC area is one of the most productive fisheries along the east coast of Florida where commercial scallop fishery predominates. A number of renewable oyster leases are also held in the waters near KSC.

KSC and the surrounding coastal areas provide habitat for over 300 bird species; nearly 90 species are resident breeders, over 100 species winter at KSC, and the remainder are migratory. Twenty-four species are on the protected species list. More than 31 species of mammals inhabit the Merritt Island land mass, including the white-tailed deer, feral hog, and bobcat. Two mammals are aquatic: the Atlantic bottlenose (river resident) dolphin and West Indian manatee *(Trichechus manatus)*. Ten species of mammals are Federally protected. Fifty-two species of reptiles (12 Federally protected) and 16 amphibian species (one is a Species of Special Concern) are known to inhabit the KSC area. (KSC 1994, GPO 1992, KSC 1992)

3.1.3.5 Threatened, Endangered, and Sensitive Species

Forty-nine (49) wildlife species and 73 plants (69 native) listed as Federally or State threatened or endangered are known to occur on ER. Animals that could potentially be affected by the X-33 Program include: Atlantic loggerhead turtle *(Caretta caretta caretta)*, Atlantic green turtle *(Chelonia mydas mydas)*, Eastern indigo snake *(Drymarchon corais couperi)*, gopher tortoise, gopher frog *(Rana capito)*, Florida scrub jay *(Aphelcoma coerulescens coerulescens)*, Southeastern beach mouse *(Peromyscus polionotus niveiventris)*, and West Indian manatee. If placement of a landing pad is required in the KSC LC-39 area, any of the wetlands flora could potentially be affected, depending upon specific location.

ER beaches encompass over 68 km (42 mi) and are critical nesting grounds for threatened Atlantic loggerhead and endangered green sea turtles. When turtle nests are located on CCAS, barriers are installed to block artificial light from launch facilities. These lights may lead hatchling turtles away from the sea, resulting in increased mortality. Other physical barriers are installed to impede inland movement by young turtles. A lighting policy has been implemented by the ER for management of exterior lights. Requirements state that low-pressure sodium lights must be used unless prohibited for safety or security purposes, and all exterior lights must be turned off when not required for mission operations. Additionally, wire mesh covers are placed over turtle nests to protect them from feral hogs and raccoons. In addition, raccoons are removed by trapping along the dune line. (KSC 1994, CCAS 1994-A)

Although the eastern indigo snake often inhabits dry, sandy areas, it is actually characteristic of moister habitats. In the drier environments, the indigo snake invariably seeks shelter in the burrows of the gopher tortoise. A population estimate of 750 has been reported by USFWS. Tracking studies highlight the importance of well-drained areas, which comprise about 2 percent of all ER lands.

Gopher tortoises use the range of coastal scrub, coastal strand, pine flatwoods, and disturbed habitats at ER. Gopher burrows can be extensive, sometimes reaching a depth of 4 m (12 ft) and a length of 9 m (30 ft). A number of important species, including the indigo snake, gopher frog, and southeastern beach mouse are known to utilize both active and abandoned burrows as refuge.

Gopher frogs are nocturnal, normally spending daylight hours within moist habitat provided by gopher tortoise burrows. Population and densities are undetermined.

The Florida scrub jay is a 30 cm (12 in) crestless jay totally lacking the white-tipped wing and tail feathers of more common and widespread blue jay. ER supports one of the largest populations in the state (approximately 50 percent) with an estimated 1,400-3,600 birds. Scrub jays avoid wet habitats and forests, preferring scrub and slash pine. Nests are usually placed 1 to 4 m (4 to 12 ft) above the ground in scrub oaks or sand pines *(Quercus geminata)*. Frequently they will nest fairly close together. Nesting usually takes place between March and May.

Preferred habitat of the southeastern beach mouse includes vegetation zones paralleling the beach and dune lines characterized by clumps of palmetto and sea grape *(Coccoloba uvifera)* and expanses of open sand. Although substantial populations remain on ER, mice are more prolific during winter months.

The Banana River is designated as critical habitat for the West Indian manatee, a massive, fusiform, thick-skinned, nearly hairless aquatic mammal. Manatees have paddlelike forelimbs, horizontally flattened tails, and cleft, lobed, fleshy upper lips set with bristles. Average weight is between 360 and 450 kg (790 and 1190 lb), and average length is 3 m (10 ft). Census reports indicate that over 20 percent of Florida's manatee population utilize Banana River lagoonal waters at ER each spring. Peak numbers are recorded in spring and fall each year. Particular care is given to ER operations which take place adjacent to or within waters which provide habitat for the manatee. The turning basin west of Hangar AF has been identified as an area of manatee concentration.

For a complete listing of the threatened, endangered, and sensitive species occurring on the ER, see Appendix B.

3.1.3.6 Cultural Resources

The KSC LC-39 area is an NRHP-designated Historic Site by virtue of the role it played in landing humans on the moon. As such, any modifications to the complex must be reviewed by the SHPO. The SHPO has long recognized that KSC LC-39 facilities are part of an actively utilized infrastructure and changes are part of the work done here. Therefore, KSC has been able to obtain approval for all required modifications to the complex, as is evidenced by those required for the Space Shuttle Program in the 1970's and 1980's. SLC-37 has been determined ineligible for listing in the NRHP. (CCAS 1996-A, KSC 1995, JPL 1995)

There are no archeological resources associated with either the SLC-37 or the KSC LC-39 site. (CCAS 1991, KSC 1995, JPL 1995)

3.1.3.7 Water Resources

The City of Cocoa is contracted to supply water to ER. The water delivered is partially chlorinated and softened; it is rechlorinated before being introduced to the CCAS/KSC system. The water distribution system at CCAS consists of 193 km (120 mi) of underground lines, eight pump stations, three fire-pump stations, and five water supply buildings. Most wells at CCAS are relatively shallow (6 to 15 m (20 to 50 ft)), but some are up to 122 m (400 ft) deep. Some wells are plugged; however, a number are deteriorated and continue to flow. According to the Brevard County Water Resources Department (BCWRD), a number of wells are still in use for irrigation, domestic use, fire protection and mosquito control. Maximum potable water storage capacity at CCAS is 2.5 million L (0.65 million gal). Nine ground level tanks store approximately 20 million L (5.3 million gal) to supply the deluge water system. Average daily demand at CCAS is 2.2 mLd (0.57 mgd); peak capacity is 3.56 mLd (0.94 mgd). The City of Cocoa can supply up to 11.4 mLd (3 mgd). Water can also be supplied to CCAS through PAFB by the City of Melbourne. (CCAS 1994-A, CCAS 1996-B)

Average daily demand for water at KSC is 3.8 mLd (1 mgd). The City of Cocoa can supply a maximum of approximately 15 mLd (4 mgd). Water can also be supplied to KSC by the City of Titusville, and six on-base wells are available. Total storage capacity at KSC is approximately 15 million L (4 million gal) in 10 AST's. KSC LC-39 has a 4 million L (1 million gal) ground storage tank and a 950,000 L (250,000 gal) elevated storage tank. An identical water tower is found in the Industrial Area. Fire suppression system booster pump stations and a potable water system emergency pump are located within the Utility Annex, which gets its supply from the VAB area ground storage tank. (CCAS 1992)

3.1.3.8 Geology and Soils

ER is constructed atop two large barrier islands and supported by a portion of the Florida plateau, a huge carbonate platform of limestone layers and other sediment. Above these limestones are sediment formations containing sand, silts, clay and coquina rock averaging 48 m (160 ft) thick.

The plateau's aggregate thickness is 600 m (2,000 ft), most of which is below sea level and extends a great distance from the coastline, comprising the ocean floor. (KSC 1992). Bedrock is a hard-to-dense limestone known as the Ocala Formation located 23 to 92 m (75 to 300 ft) below the surface. The Ocala Formation is one of the principal parts of the Florida Artesian Aquifer. The Ocala Formation is overlain by the Hawthorne Formation (a sandy limestone), Caloosahatchie Formation (a calcareous clay with fragments of shells), Anastasia Formation (coquinoid limestone), and Pamlico Formation (unconsolidated and well-graded quartz sand). Surficial geology is a mixture of permeable sand and shell materials. (CCAS 1991)

CCAS is approximately 7.2 km (4.5 mi) wide at its widest location and varies in elevation from sea level to approximately 6.1 m (20 ft) above sea level. The topography consists of a series of nearly level and gently sloping ridges interspersed with narrow, wet sloughs which roughly parallel coastal and lagoon shorelines. Soil bearing studies confirm that Cape soils support bearing loads of 1,100 to 1,800 kg (2,500 to 4,000 lb) per 0.1 sq m (1 sq ft). Test values for these soils indicate a need for stabilizing subbase materials before placement of special test equipment.

Soils and subsoils at KSC are corrosive due to various factors, including sea salts, high water tables, and reactive soil materials. Due to the chemical hydrology of the surficial aquifer, subsurface metallic piping and storage vessels corrode within a relatively short period of time. Isolation and cathodic protection are methods used to minimize corrosive effects. Polyvinyl chloride (PVC) pipe is frequently used to overcome soil conditions which destroy concrete and metallic materials. (KSC 1992)

3.1.3.9 Health and Safety

A joint contract between NASA and CCAS was implemented to handle accident cases, physical examinations, and emergencies involving the workforce. A mutual agreement for fire protection services exists between the city of Cape Canaveral, KSC, and LBSC at CCAS. Medical services are provided by an Occupational Health Facility and Emergency Aid Clinic. Facilities are staffed by medical personnel specially trained in hazards and treatment associated with operations. Medical facilities are equipped to provide first-care treatment of injuries. Ambulance service and a medically equipped helicopter are available to transfer injured personnel to full-care medical facilities. Coordination support agreements between local municipalities provide for reciprocal support in the event of an emergency or disaster. (KSC 1994, CCAS 1994-A)

Three fire stations, two located in the VAB area and one located in the Industrial Area, provide effective coverage for KSC. Fire protection services are limited at CCAS, consisting of one main fire station and two smaller auxiliary stations. Almost 10 km (6 mi) of water mains are dedicated to fire distribution; 12 water tanks provide a combined storage capacity of 23 million L (6.0 million gal). Police facilities include pass issuance, central police control, police operations, and several small entry control buildings. (KSC 1994, CCAS 1994-A)

Specific safety and health requirements for the X-33 Program will be developed by the ER in conjunction with NASA and the X-33 Phase II Industry Partner. As a minimum, the X-33

Program can expect to submit preliminary and final site plans, safety standard operating procedures, a safety assessment report, and a missile flight safety operational plan. These documents will be prepared in accordance with NASA/KSC, USAF/CCAS, and DOD regulations.

3.1.3.10 Operational Noise

Noise levels which may affect environmental attributes are primarily related to launch activities, which are single-event, short-duration sources specifically related to combustion of rocket propellant. The highest acoustic noise levels generated by Space Shuttles are recorded within the first 2 minutes of launch. In the launch vicinity, noise levels can exceed 160 dBA. Noise levels recorded at the Launch Impact Line (VAB area) do not exceed the 115 dBA maximum level established for short exposure by the Department of Labor Standards. For maximum protection, observer areas and security zones have been set at distances where the 115 dBA sound level is not exceeded (KSC 1994). Noise is usually perceived by surrounding communities as a distant rumble. A concrete exhaust flume on each pad deflects exhaust gases away from the pad to reduce noise and shock wave that result from ignition of solid rockets and the first stage of the launch vehicle. Aircraft operations create a similar source of noise; however, these are infrequent single events which usually do not exceed installation boundaries, with the exception of approach zones. (JPL 1995)

Noise levels within various industrial shop areas are monitored by NASA Environmental Health. Monitoring is conducted to ensure personnel exposure levels are in compliance with standards established by OSHA. Day-to-day operations at ER would most likely approximate urban industrial areas, reaching levels of 60 to 80 dBA, with a 24-hour average ambient noise level that is somewhat lower than the EPA-recommended upper level of 70 dBA. Other sources of noise, such as construction activity and vehicular traffic, are considered acceptable with regard to personnel exposure and have not been documented to adversely impact wildlife or other environmental attributes. The closest off-range civilian noise receptors would be commercial activities located on the north side of Port Canaveral. The majority of operations are industrial in nature, which generate local noise at levels greater than those which may be detected from ER. (CCAS 1992, JPL 1995)

Space launches generate sonic booms during vehicle ascent and stage reentry. Launch-generated sonic booms are directed upward and in front of the vehicle and occur over the Atlantic Ocean. Stage reentry sonic booms also occur over open ocean and do not impact developed coastal areas. (JPL 1995)

3.1.3.11 Transportation

<u>Roadways</u>

Federal, state, and local roads provide highway service for Brevard County. Principal routes are Interstate 95, U.S. Highway 1, and SR's 3, A1A, 402, 406, 407, 520, and 528. Bridges and causeways link urban areas on beaches to Merritt Island and the mainland. All roads have control access points which are manned 24 hours a day, 7 days a week. (CCAS 1994-A)

All paved roads conform to the American Association of State Highway and Transportation specification H20-S16. This specification establishes a load bearing capacity of 18,000 kg (20 tons) for a tractor-truck and a gross single axle weight of 15,000 kg (16 tons). Design standards for primary roads and highways mandate 7 m (24 ft) widths and, for two lane roads, a 12 m (40 ft) wide median strip.

CCAS has 130 km (81 mi) of paved roads serving various launch, support, and Industrial Area facilities. The road system is linked to the regional highway system by NASA Causeway to the west, SR 402 to the north, and the CCAS south gate and State Highway A1A to the south. There are approximately 332 km (206 mi) of roadway at KSC, with 254 km (158 mi) of paved roads and 77 km (48 mi) of unpaved roads.

Railroads

The Florida East Coast (FEC) Railway affords rail service to the county, with a main line through the cities of Titusville, Cocoa, and Melbourne. The spur spans the Indian River and Intracoastal Waterway via a causeway and bascule bridge on the mainland to Merritt Island. Approximately 64 km (40 mi) of rail track provide heavy freight transport to ER (KSC 1994, CCAS 1994-A). NASA owns its own railroad at KSC. Sixty-four km (40 mi) of track extends from the FEC Railway in Titusville across the Indian River, through KSC to CCAS. Three locomotives and approximately 65 railcars provide service to NASA, USAF, U.S. Army, USN, other agencies, and space launch contractors. Annual traffic is approximately 3,000 cars. The railroad is used to transport hazardous materials and equipment, Space Shuttle components, and over-dimensional freight. (NASA 1996-B)

Airports

Major commercial air service facilities are located at the Orlando International Airport. Most major domestic and several international airlines serve the airport. The Melbourne International Airport is located in southern Brevard County and provides the Space Coast with major international and regional carriers. The Space Center Executive Airport, located in northern Brevard County near Titusville, is a full service facility for corporate and commercial jet traffic. In addition, the Merritt Island Airport, Rockledge Air Park, and Arthur Dunn Airport are all Brevard County fixed-base operators with asphalt runways ranging from 620 to 915 m (2,000 to 3,000 ft). Military airfields are located at CCAS and PAFB. (KSC 1994, CCAS 1994-A, USAF 1996)

Seaports

Port Canaveral, located at the southern boundary of CCAS, is the area seaport. Navigable access from Port Canaveral to ER docking facilities at Hangar AF (CCAS) and the Barge Turning Basin (KSC) is provided by 31 km (19 mi) of maintained channels. Docking facilities at Hangar AF are used primarily in retrieval of SRB motors following launch of the Space Shuttle. The Turning Basin is used to unload external fuel tanks and other heavy equipment suited to waterway transport. A total of 480 m (1,580 ft) of dockage is available at existing wharf facilities. Industrial and commercial facilities are located at the port, and cruise ship use is increasing. (KSC 1994, CCAS 1994-D)

An area transportation map is depicted in Figure 3.1-10.

3.1.3.12 Population and Employment

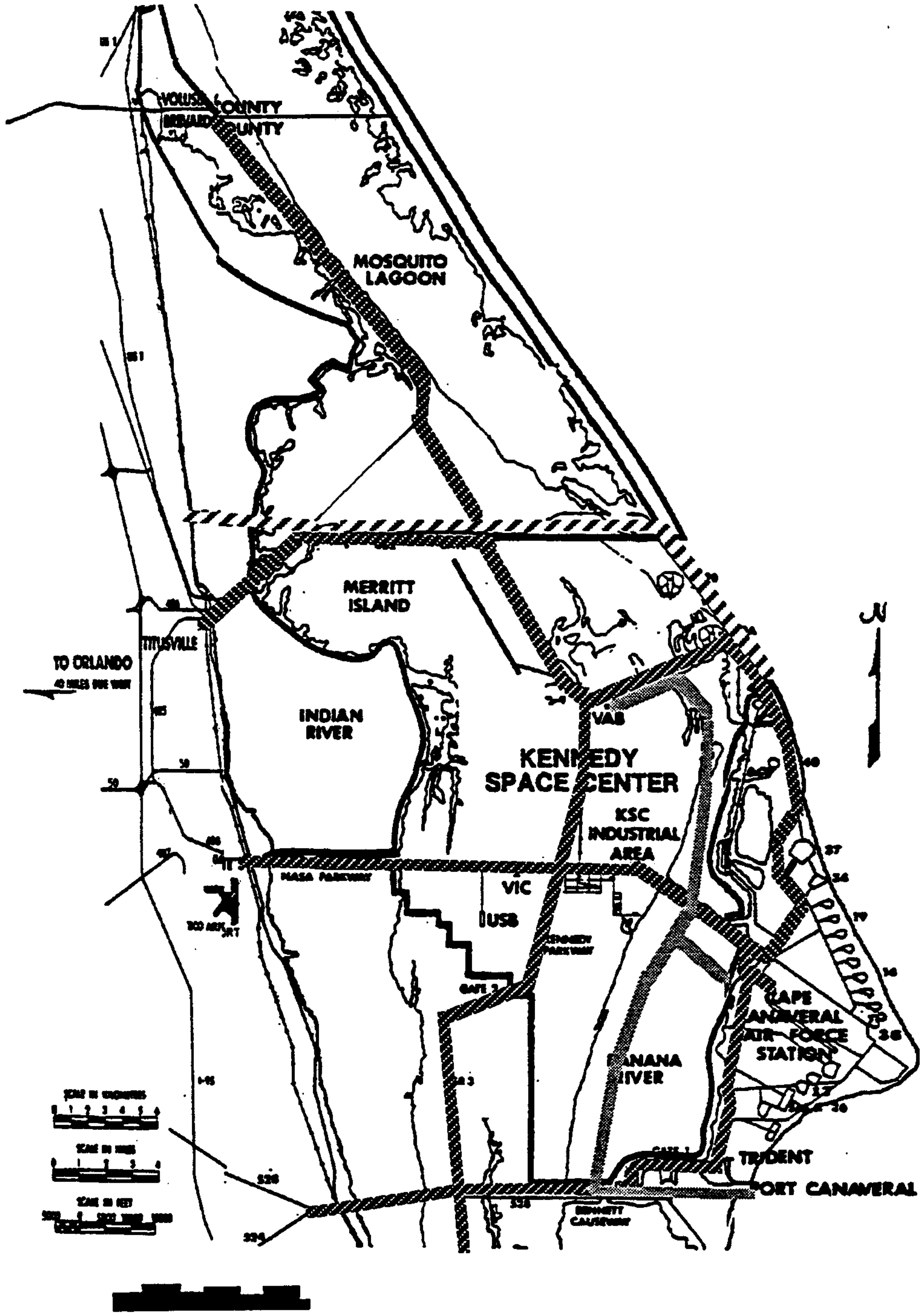
The Brevard County 1990 census population was 398,978; however, more recent estimates approach 435,752. The communities of Palm Bay, Melbourne, and Titusville are the largest, with populations that approximate 71,476, 65,583, and 40,978 respectively. Major employers include CCAS, PAFB, KSC, and technical and aerospace firms located south of Titusville, in Melbourne, and in Palm Bay. The presence of DOD, NASA, and the technical and aerospace firms represents a predominant economic force, generating an estimated employment population of 80,000. (KSC 1994, CCAS 1991)

Approximately 18,253 personnel were employed at KSC at the end of September 1993, including contractor, construction, tenant, and permanent civil service employees. Civil service employees account for approximately 14 percent of the total workforce. Approximately 50 percent of the personnel at KSC have positions directly related to the Space Shuttle and payload processing operations. The remainder are employed in ground and base support, unmanned launch programs, crew training, engineering and administrative positions. (KSC 1994)

The highest employment levels were recorded during the Apollo Program. In 1968, a peak population of 25,895 was recorded and an estimated one in four workers in Brevard County were employed by operations at KSC. Employment levels dropped precipitously following the Apollo Program to a historic low in 1976 when a total of 8,441 personnel were employed. Employment levels rose in 1979 when KSC was designated as the launch and operations support center for the Space Shuttle Program, gradually increasing through 1985 as the number of launch events increased. (KSC 1994)

3.2 Global Environment

The main global environmental issues relevant to the X-33 Program are related to the tropospheric and stratospheric layers of the atmosphere. The Earth's atmospheric layers are delineated in Figure 3.2-1. X-33 test flights will occur in and transit all layers of the Earth's atmosphere, to altitudes exceeding 75 km (47 mi). Consideration of the effect of X-33 and successor RLV's which will orbit at altitudes exceeding 160 km (100 mi) on the troposphere and especially the stratosphere are important since these effects cannot be mitigated.



Major Road Access
Barge Access
Rail Access

Figure 3.1-10. KSC and CCAS Transportation Map

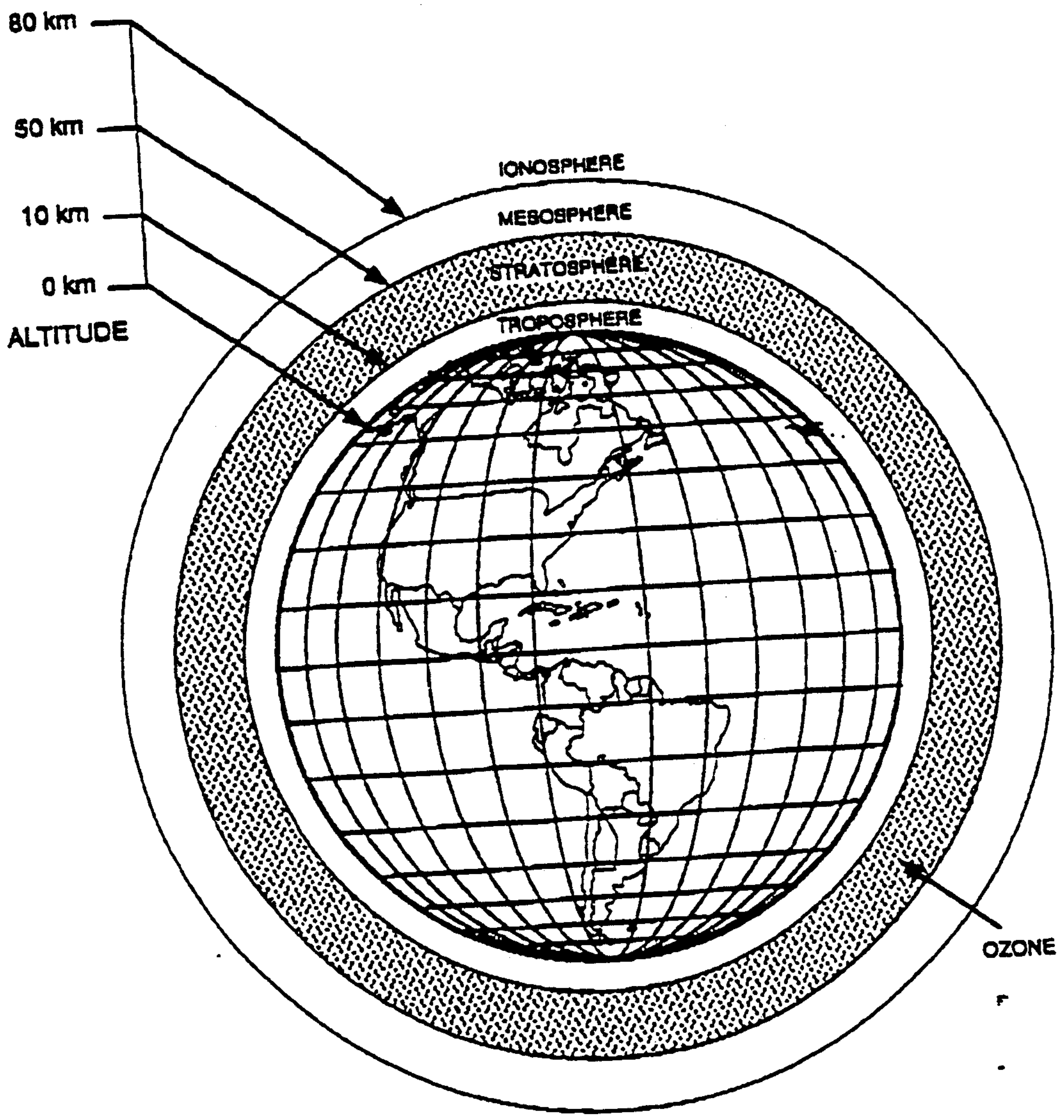


Figure 3.2-1. Location of the Earth's Atmospheric Layers

3.2.1 Troposphere

The troposphere extends from sea level to approximately 10 km (6 mi) of altitude. A global concern to the troposphere is the "greenhouse effect." Shortwave light or radiation from the Sun is transmitted through all atmospheric layers to the Earth's surface, where it heats the Earth and its atmosphere, resulting in the emission of long-wave (infrared) radiation. Part of the outgoing infrared radiation is trapped by trace gases in the troposphere, an effect called "greenhouse warming." Manmade gases, especially carbon dioxide, have been increasing in concentration. Concern that significant increases in "greenhouse gases" will elevate the Earth's average temperature and negatively affect or alter the natural balance of our ecosystems has resulted in panels being formed to address "greenhouse warming" issues (NAS 1991).

3.2.2 Stratosphere

The stratosphere contains the "ozone layer" which protects Earth's biological systems—plants, animals, and humans—from dangerous ultraviolet-B (UV-B) light which can cause skin cancer, cataracts, and other genetic alterations (NAS/NRC 1984, EPA 1987, Monastersky 1990). The stratosphere spans an altitude range of approximately 10 km (6 mi) to 50 km (30 mi). This atmospheric layer has been the subject of intensive research due to scientific theories, projections, and preliminary evidence that manmade chemicals, especially chlorofluorocarbons such as freon, are reducing ozone concentrations in the stratosphere. (Molina/Rowland 1974, NAS/NRC 1984, WMO 1985, WMO 1989, WMO 1991, WMO 1994)

Worldwide concern led to the first international meeting in Montreal, Canada, in 1987, devoted to understanding and policy formulation of protection of the stratosphere. Currently, ninety-two (92) countries, including the U.S., are parties to the "Montreal Protocol."

4.0 Environmental Consequences and Mitigation

4.1 Summary of Relevant Issues and Status of Issues

Impacts of the X-33 Program at each proposed takeoff site and on the global environs vary from none to potentially wide-ranging. Results of the analyses are summarized in Table 4.1-1.

Impacts were classified in one of six categories:

- Not Applicable (N/A) - those activities not related to the site specific or global environment
- None - those areas in which no impacts are expected
- Minimal - those areas in which the impacts are not expected to be measurable or are too small to cause any degradation to the environment
- Minor - those impacts which will be measurable but are within the capacity of the impacted system to absorb the change or can be compensated for with little effort and resources so that the impact is not substantial
- Major - those environmental impacts which individually or cumulatively could be substantial
- EA-II - those issues which, through lack of design data and/or proposed operational plans, could not be analyzed

Those issues classified in one of the first four categories will not be addressed in subsequent NEPA documentation except to describe specific mitigation to ensure that environmental impacts for that medium will not be substantial or major.

4.2 Takeoff Control and Support Operations (Primary Sites)

4.2.1 Facilities and Infrastructure

All three ranges which are considered reasonable alternatives are large test facilities employing thousands of Government and contractor personnel. In order to perform their assigned functions, they have established a substantial infrastructure to support test and day-to-day activities.

<u>Wastewater Treatment</u>

EAFB operates three separate wastewater collection and treatment facilities serving various portions of the base. The Main Base facility, with a design capacity of 5.7 mLd (1.5 mgd), is currently treating an average of 6.3 mLd (1.7 mgd). In order to alleviate the capacity shortage, a new tertiary treatment plant will be put in service in 1996. The new plant is designed to treat

Table 4.1-1. X-33 Relevant Issues and Status of Issues Matrix

ISSUES	EAFB	WSMR	ER	OFF-RANGE/ GLOBAL
Facilities and Infrastructure (Combined)	Minimal	Minimal	Minimal	EA-II
Wastewater Treatment	Minimal	Minimal	Minimal	EA-II
Electricity	Minimal	Minimal	Minimal	EA-II
Communications	Minimal	Minimal	Minimal	EA-II
Natural Gas	Minimal	Minimal	Minimal	EA-II
Fuel	Minimal	Minimal	Minimal	EA-II
Hazardous Waste	Minimal	Minimal	Minimal	EA-II
Nonhazardous Solid Waste	Minimal	Minimal	Minimal	EA-II
Air Quality (Combined)	Minor	Minor	Minimal	EA-II
Airspace				
On-Range Flights	None	None	None	N/A
Off-Range Flights in Range-Controlled Airspace	Minimal	Minimal	Minimal	Minimal
Off-Range Flights Outside of Range-Controlled Airspace	N/A	N/A	N/A	EA-II
Biological Resources (Combined)	Minimal	Minimal	Minor	EA-II
Threatened, Endangered, and Sensitive Species	EA-II	EA-II	EA-II	EA-II
Cultural Resources	EA-II	EA-II	Minimal	EA-II
Water Resources				
Domestic/Industrial	Minimal	Minimal	Minimal	EA-II
Takeoff Deluge	Minor	Minor	Minimal	EA-II
Geology and Soils	Minimal	Minimal	Minimal	EA-II
Hazardous Materials				
Contamination	Minor	None	Minor	EA-II
ES/QD's	None	None	None	EA-II
Transportation	None	None	None	EA-II
Health and Safety				
Flight Safety	Minimal	Minimal	Minimal	EA-II
Non-Flight Safety	None	None	None	EA-II
Land Use	None	None	None	EA-II
Operational Noise	Minimal	Minimal	Minimal	EA-II
Transportation	Minor	Minimal	None	EA-II
Population and Employment	Minimal	Minimal	Minimal	EA-II
Flight Noise and Sonic Booms	None	None	None	EA-II
Off-Site Safety (Overflight)				
Flight Safety	EA-II	EA-II	EA-II	EA-II
Non-Flight Safety	EA-II	EA-II	EA-II	EA-II
Troposphere	None	None	None	None
Stratosphere (Ozone)	None	None	None	Minimal

Key to the Categories:

N/A: The issue has no relevance to the site or global environs.

None: There are no impacts expected.

Minimal: The impacts are not expected to be measurable or are too small to cause any degradation to the environment.

Minor: Those impacts which are measurable but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so that the impact is not substantial.

Major: Those environmental impacts which individually or cumulatively could be substantial.

EA-II: Those issues which, through lack of design data and/or proposed operational plans, could not be analyzed. Further discussion of these items is deferred to EA-II.

9.5 mLd (2.5 mgd), which should alleviate current and projected future capacity problems. The other two systems are operating within respective design capacities.

WSMR operates a sewage collection and treatment plant which treats both industrial and domestic wastewater generated on the Main Post. There are also smaller sanitary facilities serving outlying areas. The Main Post system and SRC plant area are currently operating at 50 and 20 percent of respective capacities.

KSC operates five domestic WWTP's which currently operate at less than 50 percent capacity. The facility of primary interest to the X-33 Program is the KSC LC-39 holding tanks. The system is designed to handle sound suppression, fire suppression, and postlaunch washdown water from Space Shuttle launches. This volume of water is considerably larger than that expected to be generated during X-33 takeoff. CCAS has 15 WWTP's which will be replaced by a new plant currently under construction. The new plant will have sufficient capacity to treat current wastewater in addition to deluge water from launch operations, while still having excess capacity for expected demand increases.

Wastewater impacts from the X-33 Program will consist of two types: domestic wastewater resulting from additional personnel and industrial wastewater resulting from processing and launch operations. It is anticipated that during site preparation and flight test operations, approximately 100 additional people will be working on the range. Compared to normal range populations, this increase is minimal. Industrial wastewater will result from X-33 spaceplane cleaning operations; spaceplane processing and repair, such as TPS repairs; and water deluge/sound suppression systems used during takeoff. No new processes are involved; therefore, wastes are expected to be similar to those resulting from normal launch operations. Since all three ranges either have or shortly will have substantial excess treatment capacity, and the amount of extra wastewater involved is minimal compared to the normal daily water use on the ranges, the impact will be minimal.

Electricity

All three ranges receive electricity from commercial utilities in their areas. All have excess capacity as well as some emergency backup capability through the use of Government-owned electric generators on-site. The proposed EAFB sites will require extension of electric lines. The Nike Avenue and WSSH sites at WSMR and both ER sites already have electricity. The increase in demand for electricity due to the X-33 Program will be minimal in comparison to existing demand on each range. The only potential impact may be from extending power lines to the takeoff site. Overall impact will be minimal.

Communications

All three ranges have telephone and radio networks in place. The EAFB C4 has the capability to provide virtually limitless support. Only 4 of the 48 strands of a fiberoptic loop are used for the telephone system, leaving 44 strands for computer networking and future growth. WSMR has telephone and data transmission service at the existing takeoff sites. Both ER sites have existing telephone service and communication systems capable of transmitting large volumes of data from test and takeoff operations. Overall impact at each range will be minimal.

Natural Gas

Most of EAFB, WSMR, and ER have natural gas service available. A pipeline to provide service to CCAS will be constructed in the 1996-1997 timeframe. There will be minimal impact to natural gas service since X-33 Program requirements will be minimal, if any.

Fuel

All three ranges operate large fleets of vehicles and maintain adequate fuel storage and dispensing facilities to support them. The number of vehicles required to support the X-33 Program will be minimal in comparison and should result in very minimal impact.

The three ranges also maintain storage and dispensing capabilities for aviation fuels. The only potential impact involves weather observation and chase planes during test, and transport aircraft returning the spaceplane to the takeoff site. Due to the limited number of test flights, impact to aviation fueling should be minimal compared to aviation support for ongoing test activities.

PL at EAFB has had some experience, and will shortly have extensive experience, with both LH_2 and LOX. Some infrastructure is in place and more is being readied. Currently PL is conducting a program to run hydrostatic bearings in LH_2. In addition, a number of LH_2/LOX engines are scheduled to be tested during the next year.

WSMR has had some limited experience with LH_2 and LOX as a result of various test programs, but quantities have been small and on-site storage accommodated with portable tanks. WSMR does not have permanent infrastructure other than portable tanks to support LOX/LH_2 fuel requirements. WSMR personnel have been working with WSTF in order to gain the required expertise and have identified necessary equipment. Fuel impacts are anticipated to be minimal at WSMR.

At the ER, LOX and LH_2 are used in large quantities to boost the Space Shuttle and other large expendable launch vehicles. Permanent storage and delivery systems are in place at KSC LC-39. Propellant storage and delivery would have to be accommodated at SLC-37. The X-33 will use approximately 95,000 kg (210,000 lbs) of propellant (LOX and LH_2 combined). This amount is minimal compared to that utilized by the Space Shuttle (approximately 730,000 kg (1,610,000 lbs) of LOX and LH_2), and Atlas Rocket (approximately 172,000 kg (379,195 lbs) of LOX and RP-1); therefore, the impact will be minimal..

Fuel-related impacts from motor vehicles, aircraft operations, and operation of the X-33 spaceplane will be minimal at all three ranges.

Hazardous Waste

Hazardous wastes from site preparation activities generally result from sandblasting, painting, and cleaning operations. For site preparation activities, such wastes can be expected to be produced. However, given the magnitude and type of effort required, these wastes should be minimal in volume and similar in nature to those currently generated at the three proposed primary sites.

Therefore, existing collection and disposal systems at each site are expected to be able to accommodate the wastes.

Spaceplane manufacturing and operation will also produce hazardous waste largely from component cleaning and related system processing operations. These types of operations already occur at all three sites, and the volumes from this program are expected to produce only minimal changes to the current totals.

EAFB has storage capacity for approximately 153,000 L (40,500 gal) of hazardous waste and currently operates at an average of 50 percent capacity, allowing considerable capability for future requirements.

WSMR has established a central facility for storage and distribution of hazardous materials. WSMR also has a central hazardous waste storage facility where the wastes are properly manifested to an off-site contract disposal facility. Disposal of hazardous waste generated during site preparation, on-site spaceplane processing, and flight operations will be handled by this facility.

Spaceplane operations will also result in some volume of residual fuel (LH_2 and LOX) to be removed immediately after each flight. The amount will depend on the specific spaceplane. All three proposed sites are able to handle both fueling operations and removal of residual fuels using safe procedures to vent these gases to the atmosphere.

Hazardous waste generated by the X-33 Program will result in minimal impact at all three ranges.

Solid Waste

The primary disposal method of nonhazardous solid waste, including residential, construction/ demolition, commercial, industrial and yard waste, is in landfills located on the ranges. EAFB operates one landfill and a recycling facility. WSMR operates three landfills. KSC recently opened a new landfill and operates its own recycling facilities. CCAS maintains its own landfill for construction and demolition debris generated from Air Force projects, plus sends some waste off-site. Solid waste generated by the X-33 Program will consist of a relatively minimal amount of debris and waste generated by the 100 test program personnel during normal operations. The amount of waste will be minimal compared to the waste produced daily by regular base operations; therefore, the impact will be minimal at all three ranges.

Combined Facilities and Infrastructure Impacts

The X-33 Program would result in minimal combined facilities and infrastructure impacts. These impacts and their severities vary by range. It is anticipated that all of the identified infrastructure impacts could be compensated for with minimal effort and resource expenditure or would be of so little consequence that no compensation would be required.

4.2.2 Air Quality

Impacts to air quality may result from four activities of the X-33 Program: site preparation activities, new or modified stationary air emission sources, increased mobile sources such as vehicular traffic, and emissions from the X-33 spaceplane exhaust. Each air quality impact will be discussed separately.

Site preparation activities generally produce air pollutant emissions in the form of particulate matter (dust) from earth moving actions, and hydrocarbons and particulates from site preparation vehicle exhausts. Regardless of the site, such activities are expected to be minimal in scope and of short duration. Facilities required for this program are few, and the land required is relatively small (maximum of 4 ha (10 ac)). Additionally, emissions from earth moving can be mitigated by using Best Management Practices (BMP's), such as water spraying, placement of hay bales in desert areas, and other forms of dust control. The number of site preparation vehicles is also expected to be relatively small. Therefore, impacts from these activities are expected to be minimal.

The X-33 Program plans to only produce one technology demonstration vehicle. Therefore, there will be no need for new or greatly increased production facilities which would have air pollution sources. Neither will the new or expanded facilities at the selected primary site require addition or enhancement of major stationary air pollution sources. The takeoff pad itself would not contain any air sources other than venting from stationary LH_2 or LOX storage tanks or emergency power generators. The former involves no regulated air pollutants, while the latter would produce only minimal amounts of emissions at irregular intervals. Therefore, only minimal impacts to air quality are expected from these sources.

The number of commercial vehicles required for operations is small. These do not represent a major increase in traffic other than that already experienced by the potential sites. The number of personnel required is also small (less than 100). The increase in vehicle loading is not expected to be measurable; therefore, these sources are expected to produce only minimal impacts to air quality at any of the sites.

The last category of emission sources is the exhaust from the X-33 spaceplane itself. The only propellants that will be used are LH_2 (fuel) and LOX (oxidizer). These propellants produce only water as a byproduct of combustion. Water is not a regulated air pollutant and does not pose any threat to air quality regardless of the site selected.

Since the sole combustion product of the X-33 spaceplane is water and the use of solvents in the volatile organic compound family of chemicals will be minimal, no conformity determination for air quality is needed.

EAFB and WSMR could have a potential impact from dust blown into the air during takeoff. There is a possibility that enough dust could be put into the air that air quality standards for a localized area within the ranges would temporarily be exceeded. Implementation of standard dust control procedures would reduce the impact to minor. Due to the existing environment at the ER, this impact is not a concern.

In summary, no potential air pollution impacts from the X-33 Program are of sufficient size, type, or scope to produce major impacts to local air quality regardless of primary site selected. Due to dust generated during takeoff, minor impact to air quality at WSMR and EAFB is expected. Air quality impacts at the ER will be minimal.

4.2.3 Airspace

On-Range Flights

At EAFB, R-2508 occupies over 32,000 sq km (20,000 sq mi) in an area approximately 274 km (170 mi) long north to south and ranging in width from approximately 111 to 163 km (69 to 142 mi) east to west. There are several small towns as well as military housing centers on EAFB; the Naval Air Weapons Center, China Lake; and the National Training Center, Fort Irwin. Flight paths within this airspace will be planned to minimize exposure to these population centers.

WSMR controls 13 designated restricted airspace areas covering all of the range and some surrounding areas. In order to keep the X-33 initially away from population centers, flight will be restricted to the range and range call-up areas. This area is approximately 225 km (140 mi) in length south to north and 97 km (60 mi) in width east to west.

Due to expendable rocket and Shuttle launch operations, the ER has a substantial amount of restricted and controlled airspace. The largest block of restricted airspace is R-2934. It is approximately 81 km (50 mi) long north to south and 48 km (30 mi) wide east to west. There is also a special controlled area, FAR 91.143, extending approximately 81 km (50 mi) off the coast to support Shuttle operations. A warning area, W-497A, extends over the Atlantic Ocean for the length of the range. Due to the coastal nature of the proposed takeoff sites, X-33 flights would be almost totally over water, resulting in no potential impacts to population centers.

Since the ranges have been established for the purpose of flight testing and/or operational flights of aerospace vehicles, impacts to airspace availability within the range are part of normal operations. There are no expected on-range airspace impacts.

Off-Range Flights/Return Landing

Off-range flights in range controlled airspace may occur for flights returning to land at the same range as takeoff. Several commercial, military, and general aviation airfields in the vicinity of all three ranges use the ranges' controlled airspace by permission. Flights scheduled to pass through this airspace, as well as flights departing from affected airfields, may be delayed. However, as the flight window is expected to be of short duration (approximately 15 minutes), these impacts will be minimal. With brief flight times coupled with the low frequency of test flights, it is expected that impacts to non-range air traffic using range-controlled airspace will be minimal.

Off-Range Flights Outside of Range-Controlled Airspace

Current projections are that all X-33 flight out of range-controlled airspace and involving overflight of public property will be above 18,000 m (60,000 ft) or the altitude cutoff for positive control airspace (PCA) by the FAA. Notice of flight plans will be made by the appropriate range safety organization to the FAA for hypersonic overflight above PCA. Immediate FAA notification for priority airspace would be made in the event of an abort. Consultation with FAA will be conducted during preparation of EA-II to verify current policy, and therefore final airspace impact determination is deferred to Phase II.

4.2.4 Biological Resources

Impacts to all biological resources at EAFB will be either minimal or can readily be mitigated to minimal levels. Of the five major plant communities on EAFB, only the halophytic and arid phase saltbush scrub communities are likely to be impacted by site preparation and operation activities related to the X-33 Program. Preliminary data indicate that the total area to be prepared would be approximately 4 ha (10 ac). Given this small size and the large amount of arid phase saltbush scrub at EAFB, this area is relatively small. Impacts to overall plant community and wildlife habitat values will be minimal. No wetlands or floodplains will be impacted.

Impacts to biological resources at WSMR will be minimal and depend on the takeoff site selected. At the WSSH site, there will be no impact to any biological resource. The site is on an alkali flat in a dry lakebed. Due to its corrosive nature, no plant or animal species regularly inhabit the site. WSMR LC-39 is low dune land. Vegetation has been characterized as mesquite scrub. The only wildlife found on this site is the Texas horned lizard. If a vertical landing vehicle is selected, a landing pad will be placed near the takeoff site. Its proximity to the takeoff site will result in no additional impact other than that resulting from takeoff site preparation and operation. Due to the small size of the site (approximately 4 ha (10 ac)) and the fact that this area has been used for launch operations in the past, the biological impact will be minimal. No wetlands or floodplains will be impacted.

Impacts to biological resources at the ER will depend on the selected spaceplane configuration and the takeoff complex used. Habitat likely to be affected at SLC-37, regardless of spaceplane configuration, is largely coastal strand and coastal scrub. Most, if not all, of the area to be impacted has been previously cleared for construction of the complex in the 1960's. Natural habitat in the area is largely due to the natural recolonization of scrub and strand species. These habitats are relatively plentiful on the range (more than 50,000 ha (123,000 ac) coastal scrub and more than 600 ha (1,500 ac) of coastal strand). The amount of previously undisturbed habitat required to be cleared is expected to be very small to none. Any scrub habitat removed would be compensated for under the KSC Scrub Compensation Plan (see Section 4.2.5). For KSC LC-39 and a horizontal lander, no impacts are expected to any natural resource because no new facility construction is anticipated. For a vertical lander, a landing pad would have to be placed in close proximity to the complex. Most areas surrounding KSC LC-39 are wetlands; therefore, it is expected that the landing pad would result in the unavoidable removal of wetland habitat since flight support requirements have strict siting requirements for the safe use and handling of highly energetic propellants. The specific species impacted would have to be determined following more detailed design. However, preliminary data indicate that the total area to be prepared would be approximately 4 ha (10 ac). Given this small size and the large amount of wetland vegetation on KSC (over 20,000 ha (50,000 ac)), this area is relatively small. In addition, opportunities for mitigation actions exist on KSC to compensate for this loss. No floodplains will be impacted. Therefore, impacts to biological resources on the ER are expected to be minor and capable of being mitigated.

4.2.5 Threatened, Endangered, and Sensitive Species

All three ranges have threatened, endangered, or sensitive species residing on or migrating through them. Mitigation will differ at each site depending on the specific species found there. A listing of the threatened, endangered, and sensitive species occurring or potentially occurring on each range is provided in Appendix B.

Over 30 sensitive plant and animal species reside on EAFB. Only three are associated with the proposed takeoff sites: the desert tortoise, Mojave ground squirrel, and alkali mariposa lily. Proposed activities are not located in designated critical habitat for these species. Impacts to protected species are expected to be minimal, if any, should the X-33 Program be implemented there. However, information required for a complete Section 7 consultation must await detailed design of Phase II of the program. Therefore, further analysis will be addressed in X-33 EA-II.

Over 80 sensitive plant and animal species are found or have the potential to be found on WSMR. None are known to be present at either of the specified takeoff sites. Therefore, impacts to protected species are expected to be minimal, if any, should the X-33 Program be implemented at WSMR. However, information required for a complete Section 7 consultation must await detailed design of Phase II of the program. Therefore, further analysis will be addressed in X-33 EA-II.

On the ER, more than 30 animal and more than 15 plant species are listed, proposed for listing or otherwise of special concern. Only a small number are of concern for the X-33 Program, given the proposed takeoff and processing sites (SLC-37 and KSC LC-39). Animal species include the West Indian manatee, southeastern beach mouse, Florida scrub jay, Atlantic loggerhead turtle, Atlantic green turtle, eastern indigo snake, and the gopher tortoise and gopher frog.

The West Indian manatee is listed because of the scenario of returning the X-33 spaceplane by barge from a remote landing site. The waters in which the barge must travel to reach dock—the Banana River—are home to one of the largest populations of manatees in the world, especially in the summer months. However, safeguards are in place to protect these animals. All tug captains who run these waters are required to take specific manatee awareness training sponsored by USFWS. In addition, the number of trips anticipated for this program would be relatively small. No adverse impacts to the manatee are expected.

For activities in the SLC-37 area, the southeastern beach mouse, scrub jay, gopher tortoise, and indigo snake are of concern. The launch complex, abandoned since the 1960's, is surrounded by coastal scrub habitat. In some places, the scrub has begun to reclaim some of the previously cleared areas. All five species use the areas to live and forage. The beach mouse has been trapped directly north of SLC-37. The other four could appear anywhere on-site. The procedure NASA has used in the past for projects impacting scrub habitats was to implement the KSC-wide Scrub Compensation Plan. This is an activity wherein NASA and MINWR, operated by USFWS, have set aside 120 ha (300 ac) of scrub habitat in need of rehabilitation. When projects requiring impacts to other scrub areas are implemented, NASA funds the rehabilitation actions at a rate of 0.8 ha (2 ac) of rehabilitated scrub to 0.4 ha (1 ac) of impacted scrub. The required USAF compensation at CCAS for scrub loss is a 3:1 (scrub enhancement:scrub impacted) ratio. This effort compensates not only for impacts to the Florida scrub jay, but for other listed species utilizing this habitat as well. Therefore, prior to implementing the X-33 Program at SLC-37, NASA would perform detailed area surveys, based on the takeoff pad design, and determine the level of compensation required, if any. Results and/or compensation would be coordinated with USFWS in Jacksonville through the Section 7 process.

Loggerhead and green sea turtles nest on ER beaches. The beaches are some of the most productive nesting places in the world for these animals. Adult females come onto the beaches to lay their eggs in the spring and summer months. The hatchlings emerge 7 to 8 weeks later, dig their way to the surface, and make their way into the surf. It is at this time that they are most vulnerable, especially to predators such as birds and raccoons. However, another threat is posed to them by man. The turtles use light reflected on the water from the moon and stars to orient them to the water. Artificial lights on the dune side of the beach can confuse them and draw them away from the water. All CCAS launch complexes have produced hatchling disorientation in the past, as has interior lighting from area facilities. However, the USAF has developed a program to mark and shield nests and modify lighting on launch towers to reduce the problem. KSC LC-39 has not in the past produced a demonstrated disorientation problem. NASA, nonetheless, has also embarked on a program to survey and modify lights that might cause such a problem in the future. The problem can be mitigated (but not eliminated) by proper design, including use of low pressure sodium lamps wherever possible and shielding lights that must be a different type. A lighting management plan for the X-33 Program and consultation with USFWS would be required. Therefore, some manageable impacts to these species would be expected.

Plant species potentially impacted at SLC-37 include the beach creeper *(Ernodea littoralis)*, prickly pear cactus's *(Opuntia compressa and Opuntia stricta)*, and beach star *(Remirea maritima)*. At KSC LC-39, placement of a landing pad for the vertical lander could impact any of the wetland species on the list. Details of design would allow for detailed surveys of the proposed areas. This effort will be undertaken as part of X-33 EA-II.

Information required for a complete Section 7 consultation at the ER must await detailed design of Phase II of the program, and therefore final impact determination will be addressed in EA-II. However, based on existing compensation programs, impacts are expected to be minor.

4.2.6 Cultural Resources

All three ranges have substantial numbers of cultural resources, including historic, archaeological, and Native American sites. In addition to known sites, there are also areas with a high probability of unknown cultural resource sites.

Actions necessary to implement development of any one of the X-33 takeoff sites at EAFB have potential to impact archaeological and/or historic resource values. Based on past experience, the likelihood of encountering significant resource values that cannot be avoided and/or mitigated to insignificant levels is not probable. Previous cultural resource survey work has been completed for the large majority of the area(s) potentially affected by X-33 developments and help support this conclusion. Avoidance is the preferred treatment of all archeological and historic resources. If avoidance is not possible, evaluation and mitigation measures, including worker education programs and established management practices, will be implemented where X-33 development actions may adversely impact the resources. A Cultural Resources Survey to identify, locate, and document resources in previously unsurveyed areas may be necessary prior to project implementation. Survey results will be addressed in X-33 EA-II.

The WSSH takeoff site is not anticipated to have any impact on cultural resources since no identified cultural resource sites exist in the immediate area. There are substantial cultural resources in the WSMR LC-39 area. Mitigation may be required, primarily through locating X-33 facilities so they do not impact any of the cultural resource sites. Use of either proposed takeoff site will require a survey to identify exact locations of cultural resource sites, if any. Survey results will be addressed in X-33 EA-II.

On the ER, surveys indicate that no archeological sites are associated with either proposed takeoff site. KSC LC-39 is listed on the Register of National Historic Places due to its role in landing humans on the moon. Florida SHPO and NPS must review modifications to the complex. Cultural resource impacts on the ER will be minimal.

4.2.7 Water Resources

Impacts to water resources can be produced from several activities of the X-33 Program, such as domestic needs of employees, industrial uses of water for cleaning solutions, water deluge/sound suppression systems, and discharges to ground and surface waters.

Current water usage rates at EAFB are 16.1 mLd (4.3 mgd); at WSMR approximately 7.6 mLd (2 mgd); and at the ER 3.8 mLd (1 mgd). Since less than 100 additional workers will be employed, demand for water is expected to increase by a minimal amount in comparison to water usage in support of normal operations. Therefore, impacts are expected to be minimal .

Site preparation activities are expected to employ less than 100 people and will be of short duration, thereby minimizing impacts from this source. Operational activities are not expected to include any new or unusual processes nor to increase demand by noticeable amounts; therefore, impacts will be minimal.

The takeoff pad may or may not require water deluge. The ER is well equipped to support use of water deluge/sound suppression systems; these systems are already in place at KSC LC-39 and are currently used in launching the Space Shuttle. Use of a water deluge system may have a greater impact on EAFB and WSMR due to more limited potable water supplies. On WSMR, water may have to be trucked in to the site if potable quality water is required in the deluge system. If lower quality water is acceptable, sufficient water resources may exist on site. The impact of a water deluge system will be minor for EAFB and WSMR and minimal for the ER.

4.2.8 Geology and Soils

The only expected impacts to the geology of the three ranges result from site preparation and placement of special test equipment required at the takeoff site. There will be no geological impact due to flight operations. Required facilities are expected to include a takeoff pad and gantry structure, landing pad for the vertical lander, storage facilities for LH_2 and LOX, roadways or railways to transport the spaceplane and related equipment to the site, and all utilities. If the vertical lander is selected, a landing pad will have to be placed near the takeoff site. If a deluge system is to be used at takeoff, it must be provided. There may also be the need for some small personnel support buildings on-site.

All four EAFB sites will require placement of takeoff structures, LOX/LH_2 storage facilities, and a landing pad. They will also require extension of utilities. The Spaceport 2000 sites will require construction of a 2.6 km (1.6 mi) road. The impact on other sites that may be considered will depend on specific locations and amount of usable infrastructure. Despite the fact that EAFB is located in a relatively aseismic area to the rest of southern California, active and potentially active faults are located close enough to generate strong ground motion. For most structures, it is expected that structural damage, even from a major earthquake, would be limited to repairable damage. Use of chemicals on-site will be minimal, and no major impacts to the surrounding soil resulting from unintended and accidental releases are expected. Comprehensive geotechnical recommendations relating to foundation design and construction are detailed in the "Geotechnical Investigation Report" prepared by Dames and Moore (1991). In addition, all structures must be constructed to specific seismic performance objectives.

Both potential takeoff sites at WSMR have minimal existing infrastructure. Both sites will require placement of takeoff structures and a landing pad. Utilities are available close to the sites, and no road construction is anticipated. The WSSH site is on a dry lakebed on gypsum soil, and the WSMR LC-39 site is a clear level site in an area of low dunes. The actual amount of required disturbance to the soil at either site should be minimal.

Facility requirements will be minimal for takeoff on the ER. Both proposed sites are existing takeoff sites. KSC LC-39 is an active launch complex with most, if not all, of the required infrastructure already in place. SLC-37 is a deactivated launch complex with road access, utilities, and some buildings already in place. Modifications would be required to the takeoff pad and gantry structure, and fuel storage facilities and a landing pad may need to be placed near the complex. Since all site preparation would be accomplished inside the confines of an existing launch complex, there would be minimal impact to the geology.

In summary, the only potential impact to site geology and soil at any of the proposed takeoff sites is due to site preparation activities. The scope of activities and size of the affected area (less than 4 ha (10 ac)) will be small. Therefore, it is expected that impact to geology and soils at any of the sites would be minimal.

4.2.9 Hazardous Materials

The primary hazardous materials associated with the X-33 Program are LH_2 and LOX used as fuel and oxidizer, respectively. The flight test program will require transportation, storage, fueling, and defueling of these materials.

There may also be other hazardous materials, such as solvents, used during assembly and processing of the spaceplane; however, quantities are expected to be small due to production of only one spaceplane and limited number of planned flights (approximately 15). Handling of hazardous materials will be done in accordance with existing federal, state, local, and range specific requirements; and storage and disposal will be accomplished utilizing existing range processes and facilities.

Contamination

EAFB is currently being investigated for potential contamination in all areas of the base. Potential sites for X-33 activities may be included in the investigation. Approximately 200 individual sites have been investigated with no impact to nearby operations or installation restoration program (IRP) activities. IRP field activities are planned in conjunction with nearby base activities so that impacts are avoided. Field activities are scheduled with flexibility built in to allow down time due to contiguous base operations. For example, many locations near the Birk Flight Test Center were investigated, but only when they would not impact the B-2 mission.

None of the sites on WSMR are anticipated to have a soil contamination problem.

Previous activities at SLC-37 on the ER have potentially contaminated soils and groundwater from spills of fuels, solvents and other chemicals. A Pre-Assessment Contamination Study performed in September of 1993 resulted in the identification of two types of contaminants: dichloroethene and vinyl chloride. Maximum contamination was found to be 260 and 27 parts per billion, respectively.

Depending on the site selected during Phase II design, site specific field surveys may have to be conducted at either EAFB or the ER to determine the presence and extent of such soil (and possibly groundwater) contamination. Should contamination be found at a proposed X-33 site, a plan for remediation, avoidance, or baselining of the contamination issues with provisions developed to ensure that no X-33 activity will contribute to migration of the contaminant other than by existing conditions would have to be developed. Because the extent of such contamination is not known at this time, determination of potential impacts to cleanup operations is not possible. However, it appears that such operations would have only minor impact. Because there is no known potential for existing contamination currently at WSMR, it is listed as no impact.

ES/QD

Due to the potentially explosive nature of LH_2 and LOX propellants used by X-33, takeoff site, landing site, and propellant storage facilities have to be sited in accordance with the ES/QD separation requirements of DOD 6055.9 and appropriate USAF, U.S. Army, and NASA regulations.

The EAFB proposed takeoff sites are expected to meet ground ES/QD requirements. Fueling will most likely be from portable tanks located at the takeoff site. The tanks have been included in the siting determination. The munitions storage bunkers midway between Building 730 and the South Base Site will not be a concern because by the time of X-33 flights, use of the bunkers for munitions storage will have been phased out. In summary, there are no anticipated ES/QD related impacts for any of the proposed takeoff sites on EAFB.

Proposed takeoff sites at WSMR are already sited for similar operations. Fueling will be from portable or relocateable ground storage tanks. There should be no ES/QD related impacts at these sites.

The two proposed takeoff sites on the ER have been used for many years with aerospace vehicles using much larger quantities of LH_2/LOX than X-33 will use; therefore, all associated facilities are properly sited. Takeoff from SLC-37 will require fueling from tankers or placement of some fueling infrastructure. Tankers are already available to transport fuel from existing storage tanks on the range. KSC LC-39 has permanent LH_2 and LOX storage tanks in place.

Transportation

LH_2 and LOX will be transported to the selected takeoff site via tanker trucks designed to carry these commodities. These trucks must meet DOT design requirements in order to travel over public roadways. Design requirements are intended to minimize the possibility of a spill, fire, or explosion in the event of a vehicle accident.

All three ranges have established routes for transport of hazardous commodities on-site that are designed to minimize risk to personnel and the transport vehicle. WSMR provides a fire escort with the vehicle. EAFB and the ER do not. Due to its mission of launching the Space Shuttle and large expendable launch vehicles, the ER has extensive experience with transporting large quantities of LH_2/LOX. There have been no major incidents involving transportation of these commodities on the ER. EAFB and WSMR have had limited experience with these commodities but have also not experienced any major transportation incidents. There is no expected impact due to the transportation of LH_2/LOX on the proposed ranges.

Off-site, tankers carrying hazardous materials travel over public roadways. The X-33 Program will result in an increase in the number of shipments to the selected range. Based on stringent design requirements of the vehicles, proven safety record of the companies involved in production and transportation of LH_2/LOX, and relatively small number of additional shipments required, no impacts are anticipated resulting from transportation of hazardous materials over public roadways.

4.2.10 Health and Safety

Flight Safety

The purpose of all three ranges is testing aerospace vehicles and systems. They all have established procedures for testing new vehicles as well as established requirements for worker health and safety. Protection of facilities due to fuel, overpressure, and vehicle failures while on the ground is provided by separation distance. Hazard distances due to quantity of fuels and possible spaceplane failure will be calculated for the selected spaceplane, and no personnel will be allowed inside this distance during takeoff or landing.

Flight paths on-range will be chosen such that there is limited/minimal risk to personnel, either by flying over unpopulated areas or evacuating personnel from affected populated areas. This type of flight path clearing operation is common to all three ranges. Anticipated impacts to health and safety resulting from on-site flights are considered minimal.

Non-Flight Safety

Non-flight hazards to personnel from the X-33 flight test program result from spaceplane assembly and handling operations, fueling operations, and post-landing deservicing operations. Specific hazards encountered will depend on the spaceplane selected. Hazards will be minimized by ensuring that personnel follow detailed operating procedures for spaceplane processing activities and comply with applicable health and safety requirements. Work on all three ranges requires compliance with requirements of OSHA (29 CFR 1900-1999) to protect the health and safety of their workforce. Personnel must also comply with a variety of local and organizational regulations that address health and safety requirements more stringent than OSHA's or that address areas not covered by OSHA. All three ranges have comprehensive health and safety programs run by dedicated health and safety professionals. All personnel involved with the X-33 flight test program will be required to comply with respective range safety programs.

All of the ranges maintain emergency response capability to rapidly respond to fires, medical emergencies, and incidents involving hazardous materials. All three have on-range fire departments and maintain mutual aid agreements with fire departments in surrounding communities. At EAFB and WSMR, medical services are provided by on-range hospitals as well as occupational health clinics. The ER has on-range clinics near both proposed takeoff sites; and EAFB, WSMR, and the ER all have the equipment necessary to transport sick or injured personnel to nearby community hospitals. Health monitoring programs to minimize employee exposure to unacceptable levels of hazardous chemicals, noise, and radiation are ongoing at all three sites.

Because all of the ranges are routinely involved in flight operations of aerospace vehicles, they have adequate programs in place to minimize health and safety risks to workers from these activities. They also have the capability to rapidly and effectively respond to any of the emergency situations that could be expected to arise during the course of the X-33 flight test program. Therefore, no impacts are expected to on-site health and safety.

4.2.11 Land Use

The dry lakebeds at EAFB are primarily for aircraft development flight tests and emergency landing. Primary missions are to conduct and support tests of aircraft systems; conduct flight evaluation and recovery of aerospace research vehicles, and development and testing of aerodynamic decelerators; operate the Air Force Test Pilot School; manage, operate, and maintain the Utah Test and Training Range and the EAFB Flight Test Range; and support and participate in Air Force, DOD, other Governmental agency, foreign, and contractor test and evaluation programs. Rocket engines using a variety of propellants are currently tested at the PL. The base also provides an alternative landing site for NASA's Space Shuttle.

As a national test range, WSMR contains an extensive complex of takeoff sites, impact areas, instrumentation sites, facilities, and equipment. Missile launch sites are located throughout the range. Although numerous missile impact areas have been designated and are specified for missions, almost any non-restricted area of the range can be used for missile impact. The range is the largest overland test range available for the U.S. Army, USN, USAF, NASA, and other agency missile and test flights. WSMR has several operational areas throughout the main range that support various test missions.

Land use at CCAS is planned and managed by requirements to support highly hazardous, large-scale missile test and launch activities. The largest land use zone (57 percent) contains active and inactive launch complexes, ordnance storage, spin test, and other launch-related support facilities. The second largest land use category (31 percent) contains missile assembly and checkout buildings, explosives magazines, and the Range Operations Control Center. Port operations (1 percent) support both commercial and industrial activities, including the NASA Space Shuttle Program, Navy Trident Program, and Navy Fleet Ballistic Missile Program. Airfield operations is another 8 percent of land use; aircraft permitted to use the Skid Strip are those involved in delivery of missile components, aircraft carrying personnel engaged in official Government business, and aircraft used in direct support of missile launches. The remaining 3 percent of CCAS contains assembly and checkout buildings, laboratories, clean rooms, office buildings, and Operations and Checkout (O&M) support shops.

Overall zoning and land management objectives of KSC are to implement and maintain the Nation's space program while supporting alternative land uses in the Nation's best interest. KSC's operational areas are located on approximately 5 percent (2,630 ha (6,507 ac)) of the total land mass (56,450 ha (139,490 ac)). Approximately 62 percent of the operational areas contain LC's 39A and 39B, VAB, SLF, other direct launch and landing support structures, and various administrative, logistical, and industrial support facilities. The remaining undeveloped operational areas are dedicated as safety zones or held in reserve for future expansion.

Since operations to be undertaken by the X-33 Program are currently being performed at the proposed takeoff sites, they are compatible with the missions and capabilities of those sites. Site preparation activities are not expected to affect more than 10 acres, which is far less than 0.5 percent of current operational areas at any one range. All three sites have reserved areas for future expansion. Therefore, the X-33 Program is not expected to impose any changes in or impacts on land use regardless of takeoff site selected.

4.2.12 Operational Noise

Personnel exposure levels in industrial shops and processing facilities at the three proposed takeoff sites are routinely monitored for compliance with standards established by OSHA. The vast airspace available at EAFB and its isolated location in a remote and sparsely populated area greatly mitigate the noise caused by aircraft testing on base. Flight activities at WSMR are at high enough altitude and low enough frequency to generate sound levels anticipated to be no greater than 70 dBA. During Space Shuttle, Delta, and Titan launches at the ER, observer areas and security zones are set at distances where the 115 dBA maximum sound level established for short exposure by the Department of Labor Standards is not exceeded. Therefore only minimal impacts are anticipated.

4.2.13 Transportation

All three ranges have access to major roads and rail lines as well as good internal roadway networks. Roadway capacity is adequate for existing traffic although slowdowns can occur at gates during morning rush hours. The number of people involved in the test program (approximately 100) will have very little effect on road congestion at any of the three largely populated ranges.

Air traffic can be supported at all sites. The primary operational runway at EAFB is the hard surface runway, 04/22, on the Main Base. WSMR will use the main runway at Holloman AFB. Both the Skid Strip on CCAS and SLF on KSC can support large transport aircraft.

Of the four EAFB alternative sites, only the Spaceport 2000 Site 1 would require road improvements. Rail access to all sites would require placement of rail connects to main spurs running on or near the base. The Nike Avenue and WSSH takeoff sites on WSMR have roadway access. ER takeoff sites also have roadway access.

Where roadway access to the takeoff sites is adequate, there will be minimal or no transportation impact. However, if a takeoff site is selected that requires road or rail construction, there may be environmental, cost and schedule impacts. Based on the currently proposed takeoff sites, there will be minor impact at EAFB due to needed, substantial roadway improvements; minimal impact at WSMR due to minimal roadway upgrades; and no impact on the ER due to adequate, existing roadways.

4.2.14 Population and Employment

The X-33 Program is not expected to have substantial impacts on population or employment levels at any of the sites involved. The program will produce only one test spaceplane at an existing aerospace manufacturing plant. The exact location of production facilities will not be known until the Phase II contractor is selected. In addition, a portion of the hardware will be developed at other locations around the country and perhaps outside the United States. This dispersal of work will tend to buffer impacts to any one geographic area. However, regardless of location of the main manufacturing plant, the program will not have the effect of increasing the number of people in the immediate area. In fact, it may have the positive effect of employing individuals who might otherwise be laid off. Given the relatively few number of workers involved (less than 100), impacts would be expected to be minimal.

As for the takeoff site, site preparation activities are expected to employ a relatively small number of people (less than 100) from the local area. The result will be a small, short-term positive economic impact to the economy of the surrounding area. Placement of special test equipment is expected to last 18 months or less. Operations are expected to have an even smaller effect due to the small number of people (less than 50) to be employed for only the duration of the flight test program (approximately 18 months).

For a horizontal landing spaceplane, off-range landing sites will be impacted the least. They will be manned only during test flight operations with a very small contingent of personnel. No construction of new facilities is expected. For the vertical landing spaceplane, placement of the landing pad will require 12 to 18 months and should employ less than 100 workers. Therefore, a small, short-term boost to the economies of these sites would be expected. The scenario for operations, however, would be the same as for the horizontal landers.

Impacts on local economies at the primary flight or secondary landing sites are expected to be minimal.

4.3 Generic Alternatives - Potentially Major Issues

Specific locations of secondary landing site(s) and test flight corridors between primary operations and secondary landing site(s) cannot be evaluated in this EA as noted in Table 4.1-1, preliminary analyses of noise and safety (risk) were performed using (1) Industry Partner supplied data or (2) "reference" spaceplane specifications (see Appendix C) where specifications were incomplete. Results of preliminary analyses are provided in order to ensure that relevant and potentially major environmental issues are recognized and appreciated early in the program. The Federal Noise Control Act directs federal agencies to carry out programs to avoid noise exposures that jeopardize human health or welfare. Preliminary analyses and impact approximations are intended to provide a perspective of these issues to potentially affected regions and enhance the subsequent NEPA analysis. More detailed, refined noise and safety (risk) projections on specific secondary landing site(s) and test flight corridors will be provided in EA-II and used by NASA and the Phase II Industry Partner for determination of final flight test corridors.

4.3.1 Flight Noise and Sonic Booms

Noise is generally defined as unwanted sound. Whether that sound is interpreted as pleasant (music, for example) or unpleasant depends largely on the listener's current activity, experience, and attitude toward the source of that sound. As an example, during a NASA Orbiter reentry event, some groups of individuals will go outside to observe the Orbiter and look forward to hearing its resultant sonic boom. Hence, the attitude of the listener as well as the intensity and frequency of the sound determines the degree of annoyance.

Noise generated by the X-33 spaceplane was analyzed for four distinct flight phases:

- takeoff
- ascent (moving rocket)
- supersonic flight
- landing (vertical landing only)

Impacts of noise on human/animal populations and buildings/structures are described separately.

Noise is measured and described in several ways. Table 4.3-1 provides units and definitions of noise terminology and measurements that will be used in following discussions.

For basis of comparisons, maximum A-weighted sound levels for typical events are shown in Figure 4.3-1. Details of noise impacts and threshold levels and ranges are provided in the following sections to enhance understanding of the preliminary X-33 noise projections summarized in this EA.

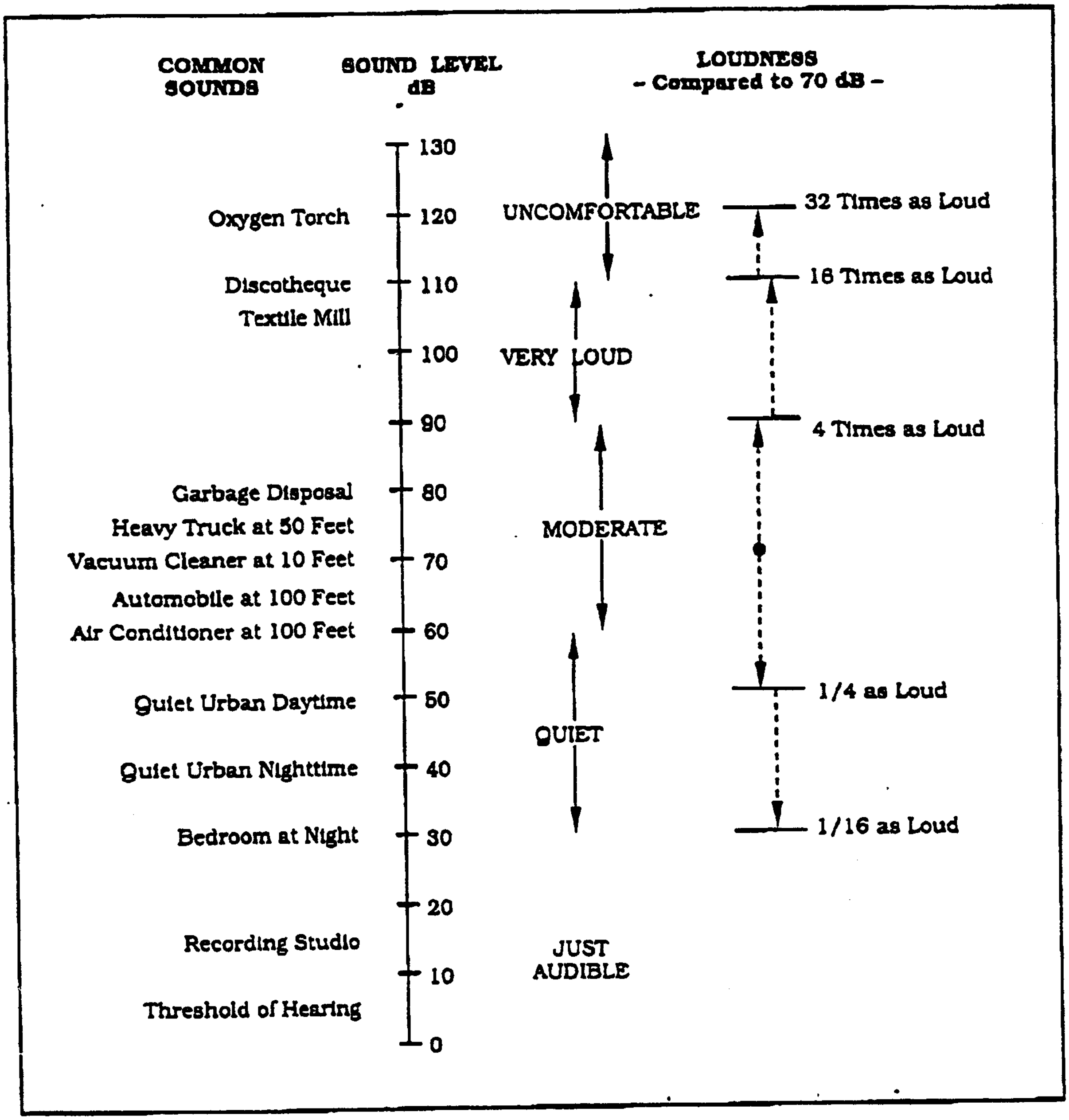
Table 4.3-1. Noise Level Units and Definitions or Explanations

Abbreviation/Unit	Term	Definition
dB $dB = 20 * \log_{10}(\overline{p'} / p_o)$ $p_o = 20 \mu N / m^2$ N - Newton, m - meter, p - pressure	decibel	Accepted standard unit of measurement of sound amplitude or "loudness" logarithmic unit.
dBA	A-weighted sound level	Adjusted sound level to the human ear's lower sensitivity to certain frequencies.
dBC	C-weighted sound level	Adjusted sound level to limit the low and high frequency portion of the sound.
cps or Hz	cycles per second or Hertz	Number of times per second air vibrates or oscillates as sound travels through it; also referred to as sound frequency. The human ear normally detects sound frequencies of 20-15,000 Hz.
OASPL	Overall Sound Pressure Level	Total sound pressure level using all frequencies.
L_{dn}	Day-Night average sound level	The 24-hour energy average A-weighted sound level with a 10 dB weighting added to those levels occurring between 10 p.m. and 7 a.m. the following morning.
psf (N/m^2 or Pa) (also expressed as dBC)	Peak Overpressure	Maximum pressure which the sonic boom produces above existing atmospheric pressure.

Community Noise and Annoyance

For the basis of evaluating the effect of noise on a community, another noise measurement used is the Day-Night Average Sound Level (L_{dn}). Time-average sound levels are measurements of sound levels that are averaged over a specified length of time. These levels quantify the average sound energy during the measurement period. L_{dn} averages sound levels at a location over a 24-hour period, with a 10 dB adjustment added to noise events that occur between 10 p.m. and 7 a.m. local time. The 10 dB "penalty" represents the added intrusiveness of sounds that occur during normal sleeping hours because of increased sensitivity to noise during those hours and typically 10 dB lower sound levels during nighttime than daytime hours. L_{dn} does not represent the sound level heard at any particular time, but represents the total sound exposure. Scientific studies and social surveys of community annoyance to all types of environmental noise found the L_{dn} to be the best measure of annoyance. Its use is endorsed by the scientific community. (ANSI 1980, ASA 1988, EPA 1974, FIC 1980, and FIC 1992)

Results by Schultz (1978) show good consistency in the attitudinal surveys conducted in different countries to find the percentages of groups of people who express various degrees of annoyance when exposed to different levels of L_{dn} (see Figure 4.3-2). In general there is a correlation coefficient of 0.85 to 0.95 between the percentages of groups of people highly annoyed and level of average noise exposure. (NOTE: A correlation coefficient of 1.0 represents 100% consistency.)



Source: *Handbook of Noise Control*, C.M. Harris, Editor, McGraw-Hill Book Co., 1979

Figure 4.3-1. Typical A-Weighted Sound Levels of Common Sounds

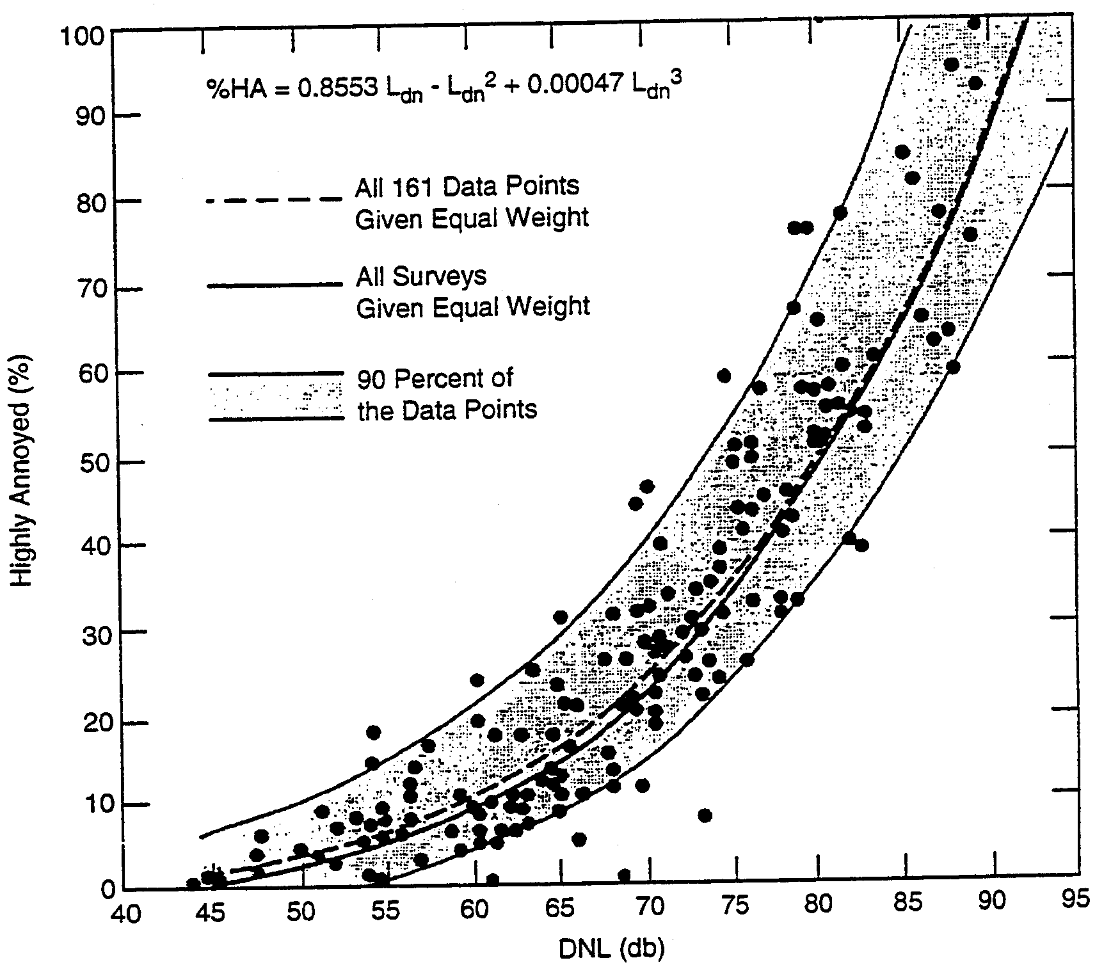


Figure 4.3-2. Community Surveys of Noise Annoyance

However, the correlation coefficient for the annoyance of individuals is relatively low, 0.5 or less, which is not surprising considering the varying personal factors that influence the way individuals react to noise.

Noise Effects on Structures

Damage to buildings and structures from noise is generally caused by low frequency sounds. To better estimate the impact of noise on a structure, a C-weighting is used. A and C weightings are compared in Figure 4.3-3. The probability of structural damage claims has been found to be proportional to the intensity of the low frequency sound. One claim in 10,000 households is expected at a level of 103 dB, one in 1,000 households at 111 dB, and one in 100 households at 119 dB (see Figure 4.3-4).

Speech Interference

Speech interference can occur at ambient noise levels above 60-70 dBA. This effect means that people engaged in conversation outdoors would have to speak louder or move closer together to continue the conversation. In some locations, the level will be above 70 dBA during tests or flight, and conservation will be momentarily interrupted. However, tests and flight noise will be of short duration, 2 to 3 minutes, and infrequent, and therefore, the impact of the disruption would be minimal.

Sleep Interference

Interference with sleep can occur at levels as low as 45 dBA. Since most people sleep at night, daytime testing activities would not interfere. People who sleep during the day must normally learn to sleep with a greater level of exterior noise. However, at levels approaching 95 dBA, some interference to daytime sleepers would be expected. Because of the infrequency of tests, the short duration, and small number of daytime sleepers, impact would be small at any site.

Sonic Booms

A sonic boom is a very short term, impulsive event. Therefore, the above noise criteria are not a good measure of its effects. There are several units used to express sonic booms. For this report, peak overpressure levels will be expressed in pounds per square foot (psf). The effect of sonic booms on humans is different than the effect of a "steady state" rocket noise. Sonic boom annoyance is better described as a startling event. Sound levels are similar to thunder from nearby lightning strikes, but can occur on a clear day. During a storm, lightning and thunder cannot be predicted to occur at a specific place or time, but they are commonplace. Therefore, some of the annoyance of sonic booms is due to their uncommon, unpredicted occurrence. Figure 4.3-5 shows a summary of survey data on the acceptance of sonic booms versus peak overpressure levels. A sonic boom of 1 psf would be accepted by 95% of the population, and a 0.4 psf sonic boom would be accepted by 99% of the population.

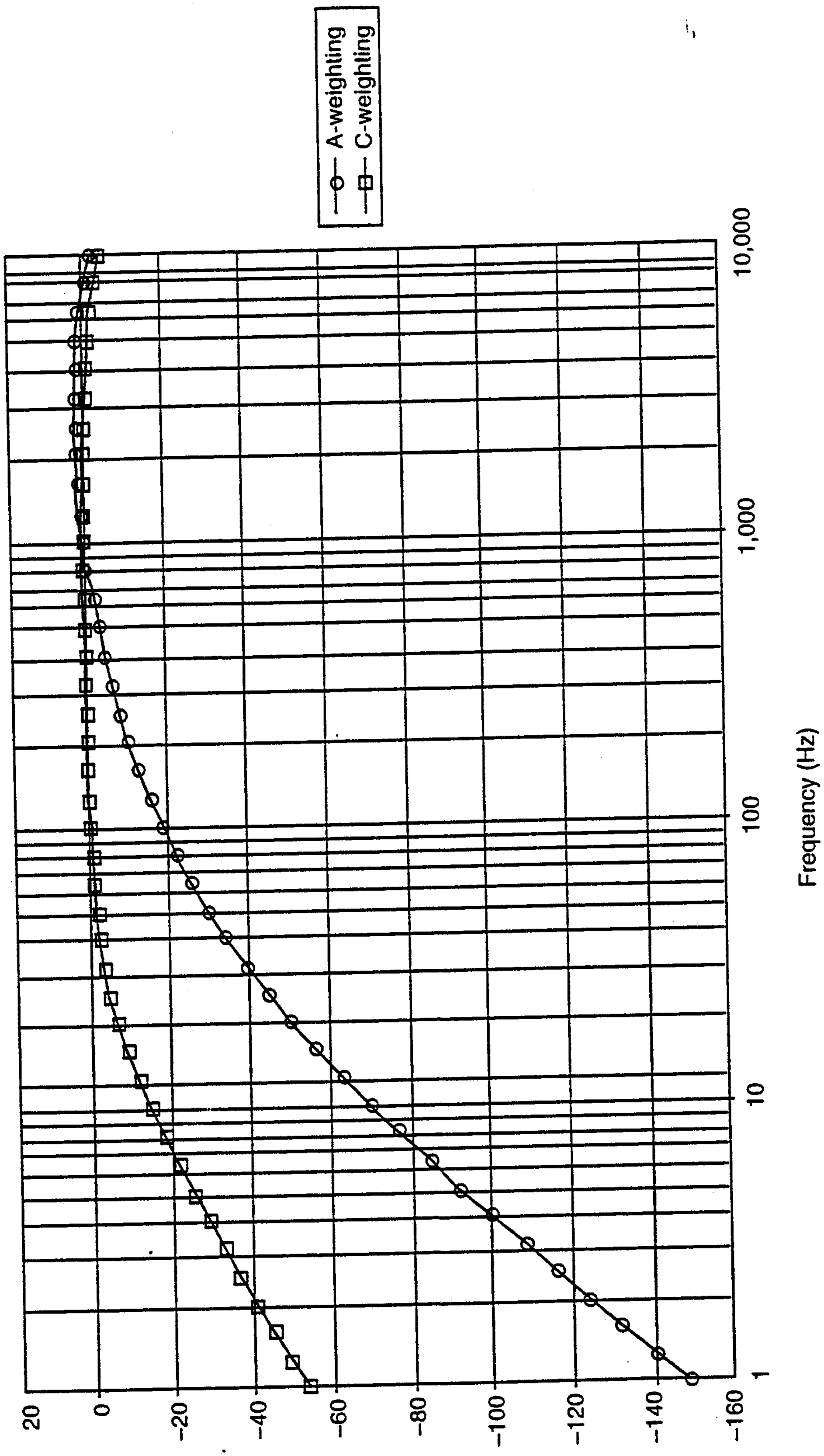


Figure 4.3-3. Comparison of A and C Weighting Curves

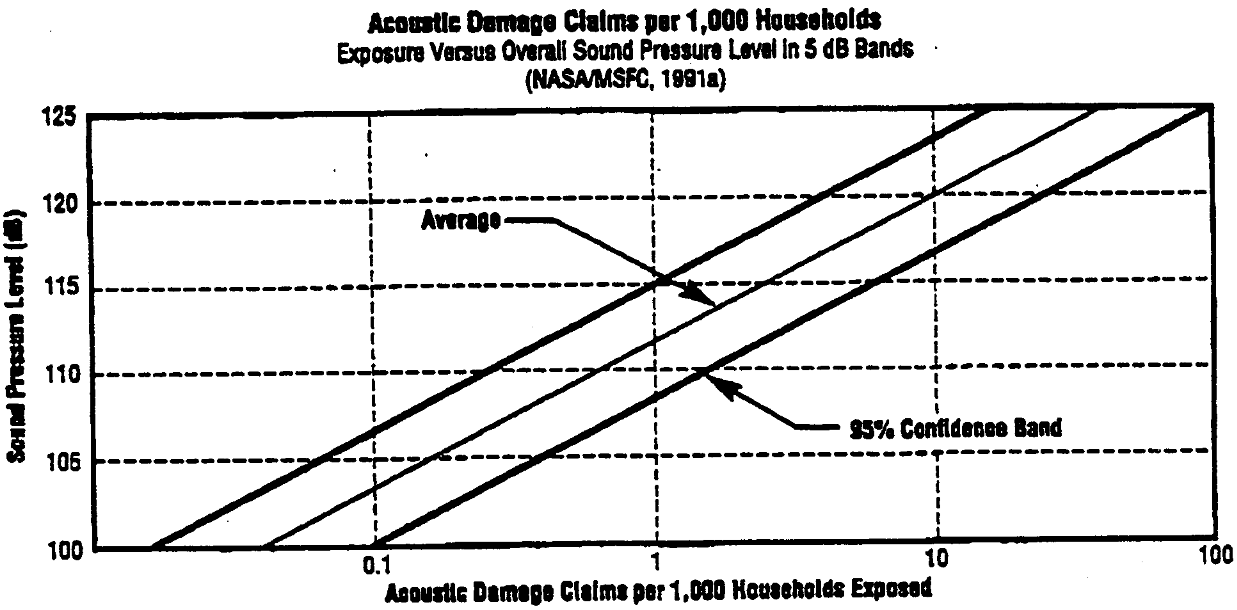


Figure 4.3-4. Structural Damage Claims versus OASPL

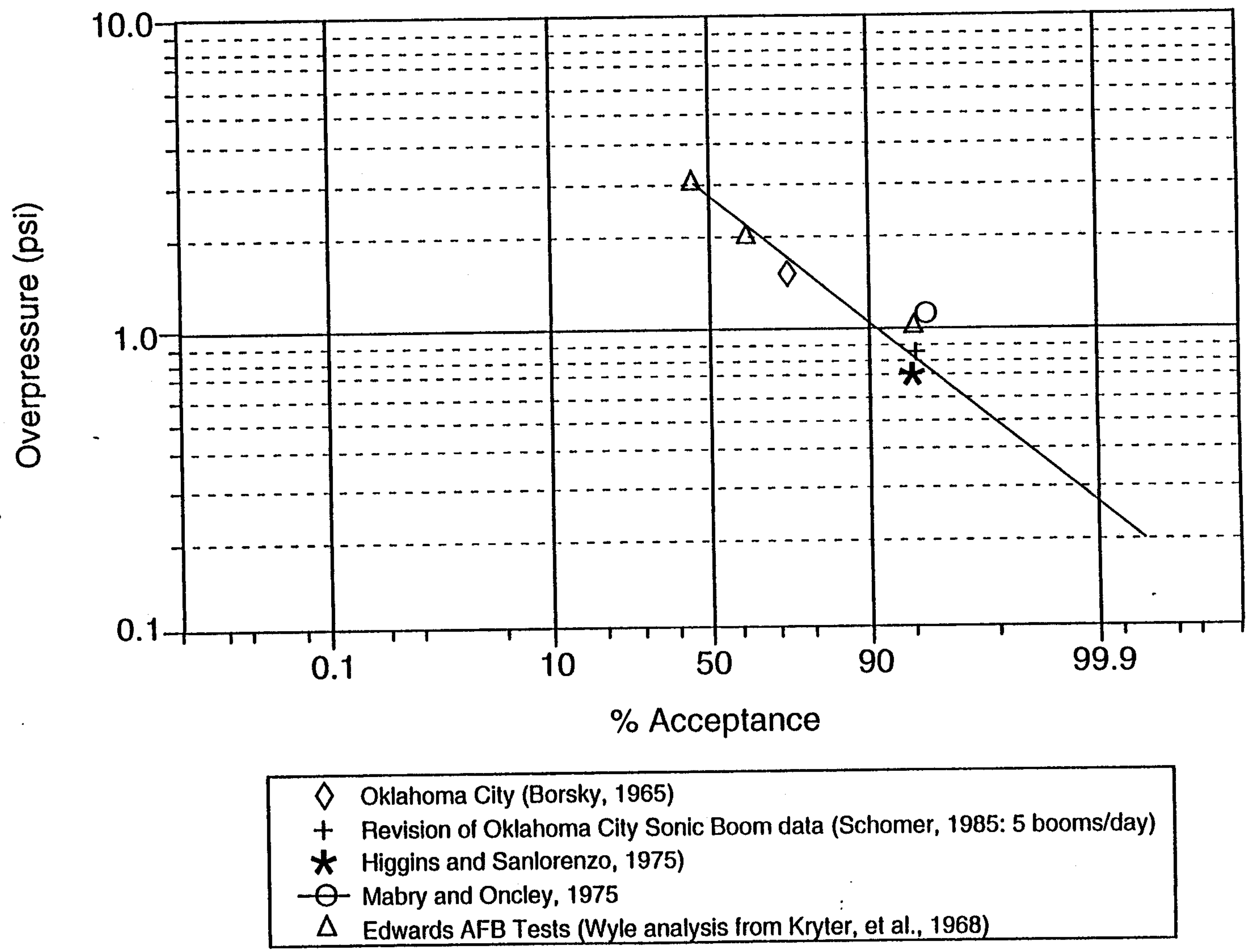


Figure 4.3-5. Summary of Sonic Boom Acceptance Data

Acoustic Focusing

Another important factor that determines the acoustic environment is acoustic focusing due to certain atmospheric conditions. This effect is related to the refraction or "reflection" of the acoustic energy as it propagates (moves) through the atmosphere. Refraction occurs when meteorological conditions of temperature and winds are such that the speed of sound increases with increasing altitude. This condition refracts the sound energy, resulting in higher levels at a given point than those which would be expected otherwise. Generally, for liftoff/static test conditions, the speed of sound profile characteristics of only the lower atmosphere (altitudes less than 5,000 to 10,000 m (16,000 to 32,000 ft)) are effective in returning sound energy to the ground. Experience shows that sound pressure levels in the far field can increase in some areas on the order of 20 dB due to atmospheric refraction effects. Acoustic focusing is not modeled in the takeoff/static test, landing, and moving rocket noise predictions in this report. The effect of refraction and how it will be predicted and mitigated will be addressed in EA-II.

Takeoff Noise

To estimate takeoff noise environments, conservative values of thrust, nozzle exit gas velocity, and nozzle exit diameter were used. This analysis assumed a takeoff pad geometry similar to Saturn or Shuttle (i.e., 45 degrees deflected exhaust). Takeoff and static test noise environments were estimated using methodology defined by the Chemical Propulsion Information Agency (CPIA 1971). The model assumes no acoustic focusing. These environments will be updated in EA-II.

Preliminary liftoff noise levels will be at or below 110 dB approximately 6 km (3.7 mi) from the takeoff site. Workers will noticeably hear takeoff at distances exceeding 10 km (6.2 mi). The above distances are within each of the ranges, and preliminary takeoff noise projections indicate that off-site receptors should not be bothered by this phase of the noise profile from takeoff.

Moving Rocket Noise

Although the moving rocket noise generation process is the same as the takeoff/static test case, the noise environment of an ascending rocket is predicted using a different model. The main differences are a deflected exhaust for takeoff/static test condition and effects of an accelerating rocket moving away from a listener for the moving rocket case. Moving rocket noise levels are a function of thrust, nozzle exit gas velocity, nozzle exit diameter, altitude, downrange distance, flight path angle, and ground track direction. Noise emission characteristics (total sound power, spectrum, and directivity) are taken from the method of Sutherland (1993) and NASA (MSFC 1963). Effects of acoustic focusing were not modeled.

The rocket engine parameters used were the same as the takeoff/static test conditions. Preliminary results for moving rocket noise are based on a trajectory considered to be typical for an X-33 ascent in terms of cross range distances and climb rate. Maximum projected dB, dBA, and dBC sound levels are at or below 100, 60, and 100, respectively, offrange. These sound levels should not annoy or damage property off the ranges. The L_{dn} and LC_{dn} values of 40 or less dB are within range boundaries. Noise projections will be refined and detailed in EA-II.

Landing Noise Environment

One of the X-33 spaceplane designs uses rocket engine thrust to decelerate and land vertically. The landing noise environment was estimated by slightly modifying the takeoff/static test noise prediction code. The main differences between takeoff and landing conditions are reduced thrust and a simple flat plate deflector used for landing. Approximately 105-110 dB overall sound pressure level (OASPL) and 100-105 dBA noise levels at touchdown would be generated within 2.5 km (1.6 mi) of the landing site. Moving rocket noise modeling on descent has not been performed and will be included in EA-II.

Sonic Boom

A typical X-33 spaceplane will fly supersonic velocities over long distances (i.e., over 500 miles). Therefore, areas overflown will experience the pressure wave generated by the spaceplane, generally referred to as a sonic boom. It is beyond the scope of this document to describe sonic boom phenomena or methodologies used to predict the event; however, a good review of sonic boom theory is presented by Plotkin (1989). In general, the amplitude, duration, and location of a sonic boom are a function of the spaceplane shock signature (shape), trajectory, and atmospheric conditions. Shock signatures for X-33 spaceplanes are similar to each other and to those of the Shuttle Orbiter. Rocket engine plumes were not modeled during the ascent phase of the flight. Plume effects will be addressed in EA-II.

Spaceplane shock signatures were developed by Plotkin (1996). Trajectories for each spaceplane were supplied by the respective Industry Partner. Atmospheric effects of temperature and winds were addressed in these predictions. EAFB annual average atmospheric temperature and wind profile were used for sonic boom footprint predictions.

Preliminary sound modeling of sonic booms produced after takeoff and focusing on a narrow region of property indicate that sound pressures of approximately 3.2 psf (see Table 4.3-2 for typical sonic boom dBC equivalents) would be experienced at distances of approximately 100 km (60 mi) from the takeoff site. Table 4.3-3 provides possible structural damages versus sonic boom sound pressures. Sonic booms with sound pressures in the range of 2-4 psf could produce damage to glass, plaster, roofs, and ceilings. Due to the nature of the X-33 Program objectives, the selected range, and trajectory(ies), sonic booms may not be confined to the test range. Careful management of the flight trajectory can minimize exposure of sonic booms on communities.

Table 4.3-2. Typical Sonic Boom Overpressure Ranges and Equivalents

Overpressure (psf)	dBC	Common Equivalent
0.5 - 2	121 - 133	Pile driver at construction site.
2 - 4	133 - 139	Cap gun or firecracker near ear.
4 - 10	139 - 147	Handgun as heard at shooter's ear.
10 - 14	147 - 150	Fireworks display from viewing stand.

Table 4.3-3. **Possible Damage to Structures From Sonic Booms (Haber/Nakaki 1989)**

Sonic Boom Overpressure Nominal (psf)	Type of Damage	Item Affected
0.5 - 2	Cracks in plaster	Fine; extension of existing; more in ceilings; over door frames; between some plaster boards.
	Cracks in glass	Rarely shattered; either partial or extension of existing.
	Damage to roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, e.g., large goblets can fall and break.
	Other	Dust falls in chimneys.
2 - 4	Glass, plaster, roofs, ceilings	Failures show which would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
4 - 10	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("Party") walls known to move at 10 psf.
Greater than 10	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plaster boards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

Preliminary Noise and Sonic Boom Footprints

Preliminary noise and sonic boom footprints were overlaid to scale on maps of EAFB, WSMR, and the ER in order to provide preliminary reference information. The maps are shown in Appendix D. No impact on any of the ranges is expected from noises or sonic booms generated during takeoff and ascent. Final determination of these impact off-range are deferred to EA-II.

Noise Effects on Animals

Effects of noise on animals are of concern at any of the three ranges, because of endangered and other listed species present near flight operations. Flight noise from the X-33 vehicle is of short duration and infrequent. Available data and field observations at active space vehicle and missile launch facilities suggest that the type of noise anticipated with X-33 flight operations will produce no cumulative effect on domestic animals and wildlife (NASA 1972, WSMR 1996-A). Startle effects should be of short duration without any substanital or permanent adverse effects.

4.3.2 Off-Site Safety

Flight Safety

The primary off-site flight safety related issue is flying an experimental spaceplane over private property and the general population. As part of the test program, flights will be traveling out of range-controlled airspace. In the case of EAFB and WSMR, once the X-33 leaves the range, it will fly over members of the general population. Takeoff from ER will be over water; however, depending on the final destination, there may be some population overflight in marine shipping lanes and at the landing site.

Since the area covered by each flight is so large, it is impractical to avoid all inhabited areas. The primary method of reducing risk is to build a spaceplane designed for very high reliability. X-33 is being designed to meet reliability requirements that exceed those of existing launch vehicles. A generic X-33 spaceplane model (see Appendix C) was used in preliminary computer simulations of off-range test flights over generic flight corridors (Figure 4.3-6) to determine potential feasibility of meeting acceptable range safety risk criteria.

Preliminary simulations by WSMR Range Safety have considered the risk to the public of explosive inflight breakup of the spaceplane. Risk data from these simulations indicate that it is potentially feasible to fly a LOX/LH_2 spaceplane over selected flight corridors. After a single spaceplane concept is selected, programmatic risk acceptance criteria will be developed in coordination with the lead range, any other affected range, X-33 Program Office and the Industry Partner. Simulations of all reasonable failure modes will be performed using the specific design and flight paths to determine where programmatic risk acceptance criteria are met. Analysis of maximum flight path deviation and debris dispersion will also be performed. Results will be included in EA-II. Risk will be mitigated through the use of a 3-phase envelope expansion program previously described in Section 2.2.4.

X-33 will have abort capability to make a safe landing in the event of a recoverable failure. Abort sites will be identified throughout the off-range flight path.

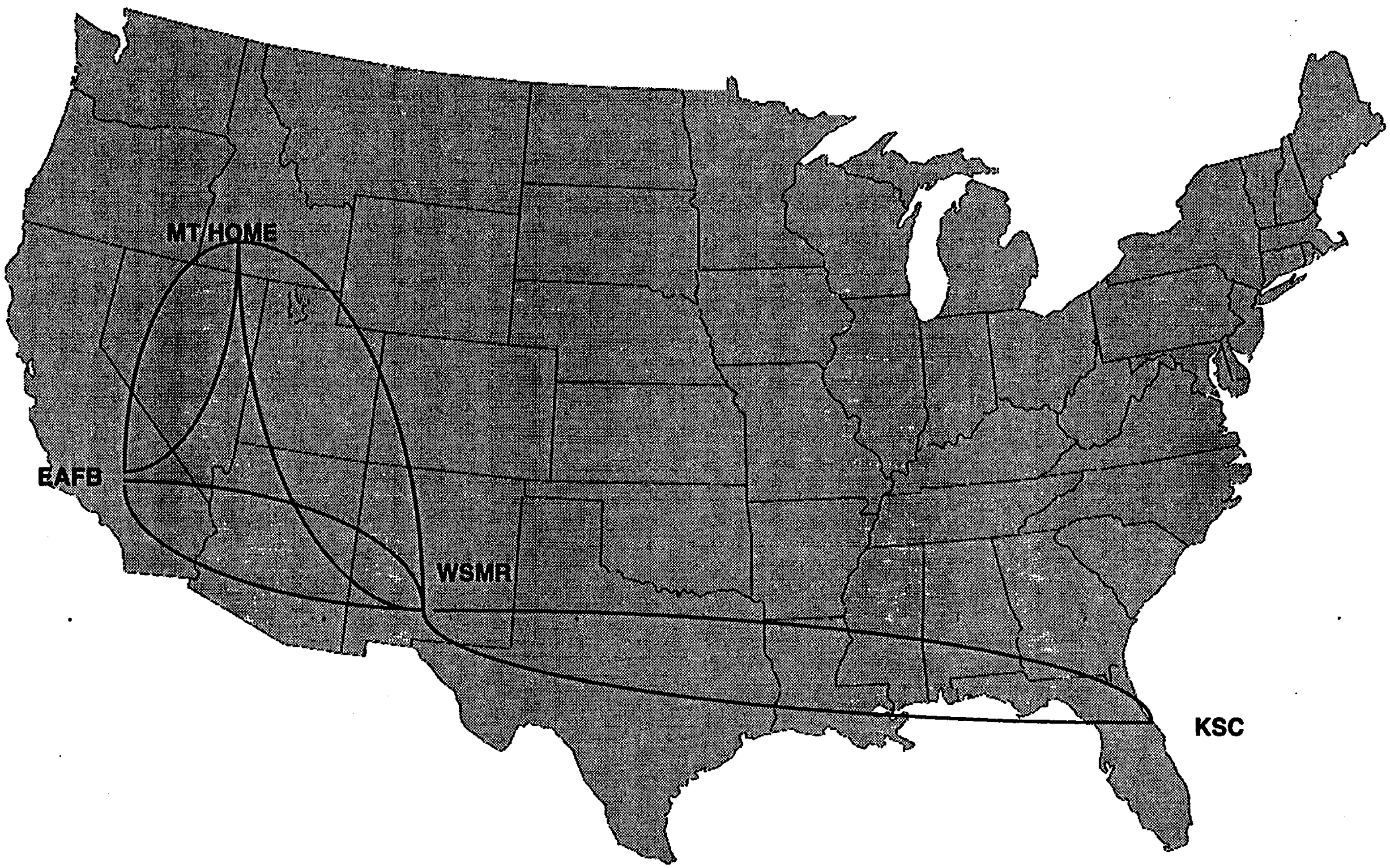


Figure 4.3-6. Representative X-33 Flight Paths

During all test flights, X-33 will have an onboard flight management system to allow controlled flight termination in the event of a non-recoverable system failure. Flight termination methods are under evaluation. Nondestructive methods such as fuel cutoff are preferred.

Non-Flight Safety

Non-flight safety issues involve potential hazards to personnel and the general public at landing and abort sites. These hazards will be handled in the same manner as on-site hazards through compliance with OSHA and other applicable health and safety requirements. In the case of abort sites and non-Government-owned landing sites, agreements with local police, fire and rescue organizations will be required. Training in any unique hazards presented by X-33 will also be required by local organizations. ES/QD separation requirements may also apply at these sites depending on residual fuel onboard at landing, mode of return to primary site requirements, etc. In the event of an abort, immediate surrounding areas may have to be cleared until the fuel is removed and the spaceplane is "safed." The extent of the clear area will depend on how much fuel is left onboard. Ensuring that non-flight health and safety issues at off-site locations are adequately addressed will involve contingency planning and cooperation with local authorities.

4.4 Global Environment

4.4.1 Troposphere

The major combustion product of X-33 test flights as well as a successor LOX/LH_2 RLV system is water. Although water vapor is a greenhouse gas, it is abundant in the troposphere. Additional amounts of water vapor to the troposphere from either X-33 or an operational RLV system would be minute. The X-33 or RLV would not contribute any other quantifiable trace greenhouse gas. Therefore, no impact to greenhouse warming from either X-33 or a successor RLV is expected.

4.4.2 Stratosphere

A spaceplane concept previously under consideration for development in the early 1990's was called the National Aero-Space Plane (NASP). Jackman, Douglass, and Brueske (1992) modeled NASP's potential effect on stratospheric ozone. NASP, whose prototype forerunner was designated "X-30," is approximately analogous to X-33 and was baselined with a LOX/LH_2 propulsion system. NASP was projected to have an approximate gross liftoff weight (GLOW) of 147,000 kg (325,000 lb), which is in the approximate GLOW range of X-33 spaceplane concepts. Yearly average global total ozone decreases were computed to be a maximum of 9×10^{-5} percent for 40 NASP test flights per year. The minimal perturbation to stratospheric ozone was attributed to a small increase of stratospheric water production (maximum 0.1 percent).

In addition, Jackman, Considine, and Fleming (1995) modeled a theoretical aerospace vehicle with comparable size and total approximate liftoff thrust to the Space Shuttle, except the propulsion system was based on using $LOX/LH_2/RP\text{-}1$. Eight annual theoretical vehicle and eight Space Shuttle launches using the same trajectories and atmospheric conditions were assumed. Based on simulation results, ozone reduction in the northern polar latitudes due to the $LOX/LH_2/RP\text{-}1$ vehicle concept would be 6,000 times less than that produced by an equivalent number of Shuttle launches. On a yearly average global basis, this vehicle concept would produce 4,000 times less ozone reduction than an equivalent number of Shuttle launches under the same conditions. Since the water contribution to ozone depletion from the vehicle concept was more important than the carbon species, such as carbon dioxide and carbon monoxide, it can be assumed that all SSTO concepts utilizing LOX/LH_2 would produce ozone reductions of approximately three orders of magnitude (1,000 times) less than current space launch vehicles whose exhaust products contain substantial quantities of chlorine. Therefore, adverse impacts on stratospheric ozone would be considered minimal for the X-33 and its successor RLV which will both fly up to altitudes exceeding 76 km (47 mi).

5.0 Pollution Prevention

Toxic Chemicals/Toxic Releases

In accordance with Executive Order (EO) 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," NASA developed pollution prevention strategies and incorporated them into "NASA Plan for Implementation of Executive Order 12856, Pollution Prevention and Community Right-to-Know" (NASA 1995-A).

NASA committed to strive to eliminate or reduce the production or acquisition of products which contain extremely hazardous substances or toxic chemicals. The Community Right-to-Know Act requires facilities that manufacture more than 11,300 kg (25,000 lb) or otherwise use more than 4,500 kg (10,000 lb) of listed toxic chemicals to publicly report their wastes and releases to EPA's Toxic Release Inventory (TRI). Federal facilities which exceed threshold requirements must develop goals to reduce releases and offsite transfers by 50 percent by the end of 1999. NASA adopted these goals. Table 5.0-1 summarizes 1995 TRI reporting for EAFB/AFFTC/DFRC, WSMR/WSTF, and the ER. These chemicals are targeted for release reduction goals.

In an effort to meet the goals set forth by EO 12856, many organizations have initiated projects affecting both the physical infrastructure and program/project operations on the ranges. Incorporating newer, more environmentally friendly processes produce benefits for many elements of the ranges involved. Some examples of technology used on the X-33 Program which will benefit pollution prevention efforts include:

- Use of graphite/epoxy composites in the manufacture of structural components to produce a structure which requires less propellant per unit weight to orbit. Composite processing is solvent free and does not require a high degree of corrosion protection; therefore, fewer materials containing volatile organic compounds are used.

- Ceramic matrix composites used to generate a stable TPS do not break apart, decompose or burn. The product is also reusable.

- Aqueous or terpene material used for surface preparation and cleaning replace or reduce the use of ozone depleting chemicals.

- LOX/LH_2 is a clean-burning propellant, releasing only water vapor into the environment.

NASA sponsors a significant number of R&D and materials substitution projects for the mutual benefit of the aerospace industry and the environment. (MSFC 1995-B)

Energy Efficiency

Pursuant to the Energy Policy Act of 1992 (Public Law 102-486 of October 24, 1992), each facility should strive to:

- reduce overall energy use by 30 percent by the year 2005 from their 1985 energy use levels;
- increase energy efficiency by 20 percent using 1990 as the baseline year;
- minimize the use of petroleum products; and
- increase the use of solar and other renewable energy sources.

Increased energy demand and use of petroleum products due to the X-33 Program will be minimal in comparison to the existing demands on each range.

Solid Waste Reduction and Recycling

Pursuant to EO 12873, "Federal Acquisition, Recycling, and Waste Prevention," each Federal facility is required to follow a waste reduction program and must have goals in place for solid waste reduction and recycling. In addition, each facility is requested to follow a waste reduction program.

EAFB and the ER operate their own recycling facilities. Solid waste generated by the X-33 Program will consist of debris and waste generated by program personnel during operations. The amount of waste generated will be small compared to daily waste produced by normal range operations.

Hazardous Waste and Oil Spill Prevention

In compliance with the Emergency Planning and Community Right-to-Know Act, each range has submitted an emergency planning notification to respective Local Emergency Planning Committees.

Table 5.0-1. 1995 Toxic Release Inventory for Ranges (Metric Tons)

Chemical	WSMR/WSTF	EAFB/AFFTC/DFRC	ER
1,1,1-Tricholorethane	---	---	12.54
Acetone	0.25	---	---
Cholordifluoromethane	---	---	---
Dicholoromethane	---	---	8.56
Dicholorotetrafluoroethane	---	---	3.25
Ethylene Glycol	---	---	4.19
Formaldehyde	---	24.33	---
Freon 113	3.51	---	107.40
Glycol Ethers	---	0.08	---
Hydrazine	0.25	---	0.65
Hydrochloric Acid	---	17.16	---
Methyl Ethyl Ketone	---	---	11.46
Methyl Hydrazine	0.25	---	0.45
Methyl Tert-Butyl Ether	---	0.02	---
Naphthalene	---	---	0.09
Propylene	---	15.22	---
Tetracholorethylene	---	---	9.20
Toluene	---	16.46	4.43
Xylene (mixed isomers)	---	---	8.62
Zinc (fume and dust)	---	---	0.68

Based upon current usage levels, not including X-33 levels.

6.0 Environmental Justice

In accordance with EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," NASA set forth its Environmental Justice (EJ) policy and goals in the "National Aeronautics and Space Administration Environmental Justice Strategy" (PD 1994, NASA 1995-B). NASA committed to integrate EJ issues and concerns into its programs, policies, and activities. Each NASA Center is required to develop an EJ Implementation Plan which takes into account activities conducted at the Center and their environmental impacts, its organizational structure and existing processes, the nature of the surrounding community, and the most effective means of communication with external stakeholders.

The Army at WSMR and the Air Force at EAFB and CCAS must also comply with EO 12898. WSMR succinctly stated that its activities will be conducted in a manner that will not exclude persons from participation in, deny persons the benefit of, or subject persons to discrimination because of race, color, or national origin (WSMR 1996-A).

NASA is committed to avoid environmental impacts wherever possible and/or practicable and to mitigate unavoidable impacts as practicable in order to strive to maintain environmental balance and minimize risk to any sector of the public due to conduct of the X-33 test flight program. Following selection of the Phase II Industry Partner, NASA will address demographics around the recommended range(s) and ensure that EJ issues are a consideration prior to finalizing X-33 flight plans. Relevant EJ data and determinations will be included in EA-II.

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8.2 Contributors

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8.3 Agencies/Persons Consulted

This EA, along with the more detailed primary operations description and results of the refined environmental analyses developed for X-33 EA-II will be used for formal consultation with appropriate regulatory authorities. Consultations and official letters of correspondence denoting their opinions will be appended to the Draft X-33 EA-II or EIS prior to public comment.

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Table 8.0-2. Contributors to the EA (Continued)

Responsible Person	Abstract	Section								Appendix			
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Table 8-2. Contributors to the EA (Continued)

		Section								Appendix			
Responsible Person	**Abstract**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**A**	**B**	**C**	**D**
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APPENDIX A

Summary of the X-Plane Program

Table A-1. Summary of X-Plane Program

Model	Manufacturer	No. of Vehicles Built	Years of Operation	No. of Flights	Primary Testing Facility	Research Goals	Program Achievements	No. of Major Accidents	Causes of Accidents	No. of Fatalities	Civilian Involvement
X-1	Bell Aircraft	3	1946-51	157	Edwards AFB	Investigate flight characteristics at greater than sonic velocities. Structural, physiological phenomena within transonic speed envelope	First Mach 1+ flight; Maximum altitude of 71,902 ft	1	Defueling Explosion	0	None
X-1A	Bell Aircraft	1	1953-55	25	Edwards AFB	Continue X-1 goals at higher speeds and altitudes	Obtained speed of Mach 2.44; Maximum altitude of 90,440	1	Explosion during captive flight; vehicle jettisoned	0	None
X-1B	Bell Aircraft	1	1954-58	27	Edwards AFB	Exploratory aerodynamic heating tests; experimental reaction control system	First reaction controlled flight	0	Not applicable	Not applicable	Not applicable
X-1D	Bell Aircraft	1	1951	1	Edwards AFB	Continue X-1 goals at higher speeds and altitudes	No major milestones	1	Explosion during captive flight; vehicle jettisoned	0	None
X-1E	Bell Aircraft, Stanley Aircraft (wings)	1	1955-58	26	Edwards AFB	High-speed wing performance	Mach 2.24, Altitude 73, 458 ft; first flight with ventral fins	0	Not applicable	Not applicable	Not applicable
X-2	Bell Aircraft	2	1952-56	20	Edwards AFB	Swept-wing performance; higher speeds and altitude than X-1	New altitude record of 126,200 ft; new speed record of Mach 2.87	2	Gasket explosion destroys first X-2; second aircraft lost to inertial coupling	3	None
X-3	Douglas Aircraft	1	1954-56	20	Edwards AFB	High speed aerodynamic phenomenon; titanium construction; takeoff, land under its own power	Led to understanding of inertia coupling	0	Not applicable	Not applicable	Not applicable
X-4	Northrop Aircraft	2	1950-53	82	Edwards AFB	Test tailless, semi-tailless configuration at transonic speeds	Showed tailless craft not suited for transonic flight	0	Not applicable	Not applicable	Not applicable
X-5	Bell Aircraft	2	1952-55	133	Edwards AFB	Investigate aerodynamics of variable-seep-wing design	Successful sweep-wing operation	0	Not applicable	Not applicable	Not applicable

Table A-1. Summary of X-Plane Program

Model	Manufacturer	No. of Vehicles Built	Years of Operation	No. of Flights	Primary Testing Facility	Research Goals	Program Achievements	No. of Major Accidents	Causes of Accidents	No. of Fatalities	Civilian Involvement
X-6	Convair Division, General Dynamics	1 shield-test aircraft (modified B-36H)	1955-57	47	Convair Testing Facility	Test feasibility of nuclear propulsion	Program terminated before prototypes constructed	0	Not applicable	Not applicable	Not applicable
X-7A, X-7A-3, X-7B, X-Q5 (unmanned)	Lockheed Missiles	61	1951-60	130	New Mexico	Test viability of ramjet engines for anti-aircraft missiles; modified to testing of powerplants	Obtained Mach 4.31, first air-breathing full-scale research aircraft designed as Mach 3 testbed	0	Not applicable	Not applicable	Not applicable
X-8A, X-8B, X-8C, X-8D Aerobees (unmanned)	Aerojet Engineering	108 (X-8 designation) 800+ (Aerobees)	1947-56	Unknown	White Sands, Holloman AFB	Upper air research, parachute recovery system	Peak altitude of 121 miles	0	Not applicable	Not applicable	Not applicable
X-9 (unmanned)	Bell Aircraft	31	1949-53	28	Holloman AFB	Test air-to-surface missiles; guidance systems, etc.	First chemical warhead test vehicle to test supersonic clusterable dispersion	9 unsuccessful flights	Servo system failures	0	Not applicable
X-10 (unmanned)	North American Aviation	13	1955-59	15	Edwards AFB	Testbed for cruise missile components	Established technology base for remote control; first Mach 2-capable target drone	3 unsuccessful flights	Communications disruption; miswiring; autopilot malfunction	0	Not applicable
X-11 (unmanned)	Convair Astronautics Division	8	1956-58	8	Cape Canaveral	Provide flight data for Atlas missile	First ICBM prototypes	0	Not applicable	Not applicable	Not applicable
X-12 (unmanned)	Convair Astronautics Division	5	1958	5	Cape Canaveral	Test 1_-propulsion-staging guidance system, nose reentry configuration	First intercontinental range mission of 6,325 miles	0	Not applicable	Not applicable	Not applicable
X-13	Ryan Aeronautical Company	2	1955-57	Unknown	Edwards AFB	Test pure-jet vertical takeoff and landing	First successful VTOL flight on jet thrust alone	0	Not applicable	Not applicable	Not applicable
X-14, X-14A, X-14B	Bell Aircraft	1	1957-81	Unknown	Moffet Field	Test VTOL technology	First VTOL aircraft using jet thrust diverter system for vertical lift	0	Not applicable	Not applicable	Not applicable

Table A-1. Summary of X-Plane Program

Model	Manufacturer	No. of Vehicles Built	Years of Operation	No. of Flights	Primary Testing Facility	Research Goals	Program Achievements	No. of Major Accidents	Causes of Accidents	No. of Fatalities	Civilian Involvement
X-15, X-15A-2	North American Aviation	3	1959-68	199	X-15 High Range (Wendover, UT to Edwards AFB)	Explore problems of space and atmospheric flight at very high speeds and altitudes	First manned hypersonic flight vehicle; altitude of 354,200 ft obtained; Mach 6.33 reached	4	Mid-flight explosions (2); loss of control (1); collapsed landing gear (1)	1	Not applicable
X-16	Bell Aircraft	Canceled	None	None	None	High-altitude, long-range reconnaissance aircraft	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
X-17 (unmanned)	Lockheed Missiles	26	1955-57	26	Holloman AFB	Explore reentry characteristics	High Mach effects on reentry vehicles	0	Not applicable	Not applicable	Not applicable
X-18	Hiller Aircraft	1	1959-61	20	Edwards AFB	Explore large VTOL vehicles	First tilt-wing usage for VTOL	0	Not applicable	Not applicable	Not applicable
X-19	Curtiss-Wright	2	1964-65	50	Caldwell; NAFEC, NJ	Test VTOL technology using radial lift	Dual-tandem tilt propeller use	1	Equipment failure	0	Not applicable
X-20	Boeing	Canceled	None	None	None	Piloted orbital flight	Provided heat materials testing	Not applicable	Not applicable	Not applicable	Not applicable
X-21A	Northrup Corporation	2	1963-64	Unknown	Edwards AFB	Test full-scale boundary control on large aircraft	Proved Laminar Flow Control viable	0	Not applicable	Not applicable	Not applicable
X-22A	Bell Aerospace	2	1966-84	501	Bell, Calspan Test Facilities	Research dual-tandem-ducted propeller configuration; research V/STOL handling using variable stability system design	Ducted fan viability, advancement of VTOL technology	1	hydraulic system failure	0	None
X-23A (unmanned)	Martin Marietta	4	1966-67	3	Vandenburg AFB/Pacific Ocean	Test configurations, control systems, and ablative materials for hypersonic reentry vehicles	First maneuverable reentry vehicle	0	Not applicable	Not applicable	Not applicable
X-24A, X-24B	Martin Marietta	1	1969-75	64	Edwards AFB	Research of aerodynamics, flight characteristics of manned vehicle with FDL-7 configuration	Verified theoretical advantages of lifting body configuration for hypersonic trans-atmospheric aircraft	0	Not applicable	Not applicable	Not applicable
X-25, X-25A, X-25B	Bensen Aircraft	3	1968		Raleigh, NC	Test discretionary descent vehicle designs	Insight on pilot training	0	Not applicable	Not applicable	Not applicable

Table A-1. Summary of X-Plane Program

Model	Manufacturer	No. of Vehicles Built	Years of Operation	No. of Flights	Primary Testing Facility	Research Goals	Program Achievements	No. of Major Accidents	Causes of Accidents	No. of Fatalities	Civilian Involvement
X-26A, X-26B	Schweizer Aircraft, Lockheed Missiles	6	1967-88	Unknown	Vietnam	Develop ultra-quiet surveillance aircraft	Use as training vehicle; contributions to stealth designs	3	Training exercises	0	Not applicable
X-27	Lockheed-California	Canceled	None	None	None	Advanced, lightweight fighter	None	Not applicable	Not applicable	Not applicable	Not applicable
X-28A	George Pereira, Osprey Aircraft	1	1971	Unknown	Philadelphia Naval Base, PA	Explore usefulness of small, single-place seaplane for civil police patrol in Southeast Asia	Unique contribution as home-built aircraft in X-Plane program	0	Not applicable	Not applicable	Not applicable
X-29A	Grumman Aerospace	2	1984-90	Unknown	Edwards	Test forward-swept wing design, advanced composites, other aero-dynamic advances	First FSW aircraft to fly supersonically in level flight	0	Not applicable	Not applicable	Not applicable
X-30	None selected	None	None	None	None	Serve as testbed for sustained hypersonic speeds within atmo-sphere or as space vehicles for orbital payload delivery	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
X-31A	Rockwell International, Deutsche Aerospace	2	1990-95	523	Edwards AFB	Break "stall-barrier," examine angles of attack	180-degree turn post-stall mancuver	1	Unknown	0	None
X-33	None selected	None	None	None	None	Develop reusable single-stage-to-orbit transportation vehicle	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

APPENDIX B

Threatened, Endangered, and Sensitive Species

Table B-1. Sensitive Species that Occur or Potentially Occur on EAFB

Scientific Name	Common Name	Federal Status	State Status
Plants			
Calochortus striatus	Alkali mariposa lily	C2	None
Cymopterus deserticola	Desert cymopterus	C2	None
Eriophyllum mohavense	Barstow woolly sunflower	C2	None
Puccinellia parishii	Parish's alkali grass	C2	None
Muilla coronata	Crowned onion	C3c	None
Wildlife			
Gopherus agassizii	Desert tortoise	FT	ST
Sauromalus obesus	Chuckwalla	C2	
Uma scoparia	Mojave fringe-toed lizard		CSC
Accipiter cooperii	Cooper's hawk		CSC
Aquila chrysaetos	Golden eagle		CSC
Buteo regalis	Ferruginous hawk	C2	CSC
Circus cyaneus	Northern harrier		CSC
Haliaeetus leucocephalus	Bald eagle	FE	SE
Falco columbarius	Merlin		CSC
Falco mexicanus	Prairie falcon		CSC
Falco peregrinus anatum	Peregrine falcon	FE	SE
Charadrius montanus	Mountain plover	C2	CSC
Childonias niger	Black tern	C2	CSC
Larus californicus	California gull		CSC
Asio flammeus	Short-eared owl		CSC
Asio otus	Long-eared owl		CSC
Athene cunicularia	Burrowing owl		CSC
Chaetura vauxi	Vaux's swift		CSC
Toxostoma lecontei	Le Conte's thrasher	C2	CSC
Agelaius tricolor	Tricolored blackbird	C2	CSC
Spermophilus mohavensis	Mohave ground squirrel	C2	ST
Taxidea taxus	American badger		CSC
Vulpes macrotis	Desert kit fox	FSS	

Federal Status

FE	Federally endangered
FT	Federally threatened
PE	Proposed Endangered
FSS	Bureau of Land Management/Forest Service Sensitive
C2	Category 2 candidate species
C3c	Category 3C candidate species

State Status

SE	State endangered
ST	State threatened
CSC	California Species of Special Concern

Source: NASA 1996, USACOE 1994-A

Table B-2. Sensitive Species that Occur or Potentially Occur on WSMR

Scientific Name	Common Name	Federal Status	State Status
Wildlife			
Sterna antillarum athalassos	interior least tern	FE	E1
Falco femoralis septentrionalis	northern Aplomado falcon	FE	E1
Falco peregrinus anatum	American peregrine falcon	FE	E1
Grus americana	whooping crane	FE	E2
Haliaeetus leucocephalus	bald eagle	FE	E2
Canis lupus baileyi	Mexican gray wolf	FE	E2
Falco peregrinus tundrius	artic peregrine falcon	FT	E1
Charadrius melodus circumcinctusp	Piping plover	FT	E1
Strix occidentalis lucida	Mexican spotted owl	FT	S
Empidonax traillii extimus	southwestern willow flycatcher	FPE	E2
Charadrius alexandrinus nivosus	western snowy plover	FPT	S
Zapus hudsonius luteus	New Mexico meadow jumping mouse	C1	E2
Cyprinodon tularosa	White Sands pupfish	C2	E2
Ammodramus bairdii	Baird's sparrow	C2	E2
Tamias quadrivittatus australis	Organ Mountain Colorado chipmunk	C2	E2
Euderma maculatum	spotted bat	C2	E2
Cicindela nevadica olmosa	Los Olmos tiger beetle	C2	none
Dereonectes neomericana	Bonita diving beetle	C2	none
Lytta mirifica	Anthony blister beetle	C2	none
Phrynosoma cornutum	Texas horned lizard	C2	S
Accipiter gentilis	northern goshawk	C2	S
Buteo regalis	ferruginous hawk	C2	S
Charadrius montanus	mountain plover	C2	S
Lanius ludovicianus	loggerhead shrike	C2	S
Plegadis chihi	white-faced ibis	C2	S
Neotoma micropus leucophaeus	White Sands woodrat	C2	S
Sigmodon fulviventer goldmani	Hot Springs cotton rat	C2	S
Cynomys ludovicianus arizonensis	Arizona black-tailed prairie dog	C2	S
Eumops perotis californicus	greater western mastiff bat	C2	S
Myotis velifer brevis	southwestern cave myotis (bat)	C2	S
Myotis lucifugus	little brown myotis (bat)	C2	S
Ovis canadensis mexicana	desert bighorn sheep	none	E1
Ammodramus savannarum ammolegus	Arizona grasshopper sparrow	none	E2
Buteogallus anthracinus	common black-hawk	none	E2
Passerina versicolor	varied bunting	none	E2
Phalacrocorax brasiliensis	neotropic cormorant	none	E2
Vireo Bellii	Bell's vireo	none	E2
Vireo vicinior	Gray vireo	none	E2
Ashmunella harrisi	land snail, no common name	none	S
Asmunella kochi caballoensis	land snail, no common name	none	S
Ashmunella kochi kochi	land snail, no common name	none	S
Ashmunella kochi sanandresensis	land snail, no common name	none	S
Ashmunella salinasensis	land snail, no common name	none	S
Oreohelix socorroensis	Oscura Mountain land snail	none	S

Table B-2. Sensitive Species that Occur or Potentially Occur on WSMR (Continued)

Scientific Name	Common Name	Federal Status	State Status
Plants			
Argemone pleiacantha ssp. *pinnatisecta*	Sacramento Prickly Poppy	FE	L1
Coryphantha sneedii var. *sneedii*	Sneed's Pincushion Cactus	FE	L1
Echinocereus fendleri var. *kuenzlari*	Kuenzlers's Hedgehog Cactus	FE	L1
Echinocereus lloydii X	Lloyd's Hedgehog Cactus	FE	L1
Hedeoma todsenii	Todson's Pennyroyal	FE	L1
Cirsium vinaceun	Sacramento Mountain Thistle	FT	L1
Cereus greggii	Night Blooming Cereus	C2	L1
Coryphantha duncanii	Duncan's Pincushion Cactus	C2	L1
Oenothera organensis	Organ Mountain Evening Primrose	C2	L1
Opuntia arenaria	Sand Prickly Pear	C2	L1
Pediocactus papyracantha	Grama Grass Cactus	C2	L1
Penstemon alamosensis	Alamo Penstemon	C2	L1
Perityle cernua	Nodding Cliff Daisy	C2	L1
Polygala rimulicola var. *mescalerorum*	Mescalero Milkwort	C2	L1
Scrophularia laevis	Smooth Figwort	C2	L2
Apacheria chiricahuensis	Cliff Brittlebush	C3c	L1
Astragalus castetteri	Castetter's Milkvetch	C3c	L2
Proboscidea sabulosa	Dune Unicorn Plant	C3c	L2
Silene plankii	Plank's Catchfly	C3c	L2
Sophora gypsophyla var. *guadalupensis*	Guadalupe Mescal Bean	C3c	L2
Coryphantha orcuttii	Orcutt's Pincushion Cactus	None	L1
Coryphantha scheeri var. *valida*	Scheer's Pincushion Cactus	None	L1
Draba standleyi	Standley's Whitlowgrass	None	L2
Epithelantha micromeris var. *micromeris*	Button Cactus	None	L1
Escobaria sandbergii	Ssandberg's Pincushion Cactus	None	L1
Enstoma exaltatum	Tall Prairie Gentain	None	L1
Mammillaria wrightii var. *wrightii*	Wright's Fishook Cactus	None	L1
Neolloydia intertexta var. *dasyacantha*	Pineapple Cactus	None	L1
Agastache cana	Mosquito Plant	None	L2
Coryphantha organensis	Organ Mountain Pincushion Cactus	None	L1
Hedeoma pulcherrimum	Mescalero Pennyroyal	None	L2
Cryptantha paysonii	Payson's Hiddenflower	None	L2
Hymenoxys vaseyi	Vassey's Bitterweed	None	L2
Perityle staurophylla var. *homoflora*	San Andres Rock Daisy	None	L2
Pseudocymopterus longiradiatus	Desert Parsley	None	L2
Salvia summa	Supreme Sage	None	L2
Sicyos glaber	Smooth Cucumber	None	L2
Talimum longipes	Long-stemmed Flame Flower	None	L2

Table B-2. Sensitive species that occur or potentially occur on WSMR (Continued)

Federal Status	
FE	Listed by the U.S. Fish and Wildlife Service (USFWS) as endangered.
FT	Listed by the USFWS as threatened.
FPE	Proposed by USFWS for listing as endangered.
FPT	Proposed by USFWS for listing as threatened.
C1	Category 1 candidate species for listing by the USFWS as threatened or endangered.
C2	Category 2 candidate species for listing by the USFWS as threatened or endangered.
C3c	Previous considered for listing by the USFWS but now considered to be to widespread or not threatened.
None	Not currently of concern to the USFWS.
State Status	
E1	Listed by the New Mexico Department of Game and Fish (NMDGF) as endangered (group 1).
E2	Listed by the NMDGF as endangered (group 2).
L1	Listed by the New Mexico Forestry Resource Conservation Division (NMFRCD) as endangered (List 1).
L2	Listed by NMFRCD as rare or sensitive (List 2).
S	Sensitive species; New Mexico species which have been singled out for special consideration, typically as being formally listed as threatened, endangered or will be in the future.

Source: U.S. Army 1994-A

Table B-3. Sensitive Species that Occur or Potentially Occur on the ER

Scientific Name	Common Name	Federal Status	State Status
Plants			
Acrostichum danaeifolium	Giant leather fern		ST
Asclepias curtissii	Curtis milkweed		SE
Asplenium platyneuron	Ebony spleenwort		ST
Avicennia germinans	Black mangrove		FSC
Calamovilfa curtissii	Curtis reedgrass	C2	SE
Calopogon barbatus	Grass pink (unnamed)		ST
Calopogon multiflorus	Many-flowered grass pink		ST
Calopogon tuberosus	Grass pink (unnamed)		ST
Campyloneurum phyllitidis	Strap fern (unnamed)		ST
Cereus gracilis	Prickly-apple	C2	SE
Cereus undatus	Night-blooming cereus		ST
Chrysophyllum oliviforme	Satinleaf		SE
Cocos nucifera	Coconut palm		ST
Conradina grandiflora	Large-flowered rosemary	C2	SE
Dryopteris ludoviciana	Florida shield fern		ST
Encyclia tampensis	Butterfly orchid		ST
Epidendrum canopseum	Greenfly orchid		ST
Ernodea littoralis	Beach creeper		ST
Eulophia alta	Wild coco		ST
Eulophia ecristata (=*Pteroglossaspis ecristata*)	False coco	C2	ST
Habenaria odontopetala	Rein orchid (unnamed)		ST
Habenaria repens	Water spider orchid; creeping orchid		ST
Harrisella filiformis	Orchid (unnamed)		ST
Hexalectris spicata	Crested coralroot		ST
Ilex ambigua	Carolina holly; sand holly		ST
Lechea cernua	Nodding pinweed		SE
Lechea divaricata	Pine pinweed	C2	SE
Lilium catesbaei	Catesby lily		ST
Lycopodium alopecuroides	Foxtail club moss		ST
Lycopodium appressum	Southern club moss		ST
Lycopodium carolinianum	Slender club moss		ST
Malaxis spicata	Florida malaxis		ST
Nephrolepis biserrata	Boston fern (unnamed)		ST
Ophioglossum palmatum	Adder's tongue fern (unnamed)3C		SE
Opuntia compressa (= *Opuntia humifusa*)	Prickly pear cactus (unnamed)		ST
Opuntia stricta	Prickly pear cactus (unnamed)		ST
Peperomia humilis	Pepper (unnamed)		SE
Peperomia obtusifolia	Florida peperomia		SE
Pereskia aculeata	Lemon vine		ST
Phlebodium aureum	Golden polypody		ST
Pogonia ophioglossoides	Rose pogonia		ST
Polygala rugelii	Big yellow milkwort		ST
Polypodium plumula	Polypody fern (unnamed)		ST
Ponthieva racemosa	Shadow witch		ST
Psilotum nudum	Whisk fern; fork fern		ST
Remirea maritima	Beach-star		SE
Scaevola plumieri	Scaevola		ST

Table B-3. Sensitive Species that Occur or Potentially Occur on the ER (Continued)

Scientific Name	Common Name	Federal Status	State Status
Selaginella arenicola	Sand spikemoss		ST
Spiranthes laciniata	Lace-lip ladies'-tresses; lace-lip spiral orchid		ST
Suriana maritima	Bay cedar		SE
Tephrosia angustissima	Narrow-leaved hoary pea; coastal hoary pea	C2	SE
Thelypteris hispidula	Aspidium fern (unnamed)		ST
Thelypteris interrupta	Aspidium fern (unnamed)		ST
Thelypteris kunthii	Aspidium fern (unnamed)		ST
Thelypteris palustris	Marsh fern		ST
Tillandsia simulata	Wild pine; air plant (unnamed)		ST
Uniola paniculata	Sea oat		FSC
Verbena maritima (=*Glandularia maritima*)	Coastal vervain	C2	SE
Verbena tampensis (=*Glandularia tampensis*)	Tampa vervain	C1	SE
Vittaria lineata	Shoestring fern		ST
Woodwardia aerolata	Netted chain fern		ST
Wildlife			
Centropomus undecimalis	Common snook		FSC
Alligator mississippiensis	American alligator	FT(S/A)	FSC
Caretta caretta caretta	Atlantic loggerhead turtle	FT	ST
Chelonia mydas myda	Atlantic green turtle	FE	SE
Dermochelys coriacea	Leatherback turtle	FE	SE
Drymarchon corais couperi	Eastern indigo snake	FT	ST
Eretmochelys imbricata imbricata	Atlantic hawksbill turtle	FE	SE
Gopherus polyphemus	Gopher tortoise	C2	FSC
Lepidochelys kempi	Atlantic ridley turtle	FE	SE
Nerodia clarkii taeniata	Atlantic salt marsh water snake	FT	ST
Ophiosaurus compressus	Island glass lizard	C2	
Pituophis melanoleucus mugitus	Florida pine snake	C2	FSC
Rana capito	Gopher frog; Crawfish frog	C2	FSC
Sceloporus woodi	Florida scrub lizard	C2	
Aimophila aestivalis	Bachman's sparrow	C2	
Ajaia ajaja	Roseate spoonbill		FSC
Aphelocoma coerulescens coerulescens	Florida scrub jay	FT	ST
Aramus guarauna	Limpkin		FSC
Charadrius melodus	Piping plover	FT	ST
Egretta caerulea	Little blue heron		FSC
Egretta rufescens	Reddish egret	C2	FSC
Egretta thula	Snowy egret		FSC
Egretta tricolor	Tricolored heron; Louisiana heron		FSC
Falco peregrinus tundrius	Arctic peregrine falcon	FT	SE
Falco sparverius paulus	Southeastern American kestrel	C2	ST
Grus canadensis pratensis	Florida sandhill crane		ST
Haematopus palliatus	American oystercatcher		FSC
Haliaeetus leucocephalus	Bald eagle	FE	ST
Mycteria americana	Wood stork	FE	SE

Table B-3. Sensitive Species that Occur or Potentially Occur on the ER (Continued)

Scientific Name	Common Name	Federal Status	State Status
Pelecanus occidentalis	Brown pelican		FSC
Picoides borealis	Red-cockaded woodpecker	FE	ST
Rhyncops niger	Black skimmer		FSC
Speotyto cunicularia	Burrowing owl		FSC
Sterna antillarum	Least tern	FT	ST
Sterna dougallii	Roseate tern	FT	ST
Felis concolor coryi	Florida panther	FE	SE
Mustela frenata peninsulae	Florida long-tailed weasel	C2	
Mustela vison lutensis	Florida mink	C2	
Neofiber alleni	Round-tailed muskrat	C2	
Peromyscus polionotus niveiventris	Southeastern beach mouse	FT	ST
Podomys floridanus	Florida mouse	C2	FSC
Trichechus manatus latirostris	West Indian manatee	FE	SE
Ursus americanus floridanus	Florida black bear	C2	ST

Federal Status

FE Federally Endangered
FT Federally Threatened
FT(S/A) Federally Threatened due to Similarity of Appearance
C1 Under review for federal listing, with substantial evidence in existence indicating at least some degree of biological vulnerability and/or threat.
C2 Under review for federal listing, but substantial evidence of biological vulnerability and/or threat is lacking.

State Status

SE State Endangered
ST State Threatened
FSC Florida Species of Special Concern

Sources: KSC 1994, CCAS 1994-D

APPENDIX C

Reference Vehicle Description

Appendix C

Reference Vehicle Description

Only one of the X-33 spaceplane concepts will be chosen for Phase II of the X-33 RLV Advanced Technology Demonstrator Program. For the purposes of this EA a "reference" or "generic" vehicle which approximates any of the Industry Partner concepts was used as the basis for preliminary range safety or "risk" analyses.

The generic reference vehicle is derived from the X-2000 Advanced Technology Demonstrator (Figure C-1) which was studied in 1993 during NASA's Access To Space study. Basic characteristics of the X-2000 important to modeling risk projections are provided in Table C-1. The X-2000 reference vehicle had similar goals to the X-33 and was a VTHL, wing body configuration with two LOX/LH_2 D-57A engines and two LOX/RP RS-27A engines (see Table C-2). It was approximately 29 m (96 ft) long with a gross takeoff weight of approximately 181,000 kg (400,000 lb). Several changes were assumed in order to make it a generic X-33 spaceplane. EA analysis was based on only LOX/LH_2 engines and on the spaceplane having a capability for vertical landing.

Table C-1. Basic Characteristics of the "X-2000" Reference Vehicle

X-2000 Advanced Technology SSTO Demonstrator			
	Weight (kg)	**Weight (lb)**	**Material**
Wing			
Carry Through Structure	680	1,500	Gr-Ep
Exposed Structure	1,547	3,410	Gr-Ep
Nose Cone	919	2,027	TITAN IV
RP-1 Tank	833	1,836	Gr-Ep
LH_2 Tank	1,220	2.690	Al-Li
LOX Tank Inc. Fwd Str	2,467	5,439	Al-Li
Aft Skirt	1,021	2,250	Gr-Honeycomb
Thrust Structure	1,118	2,464	Gr-Ep
Intertank (RP/LOX)	1,408	3,103	Gr-Honeycomb
Intertank (LOX-LH_2)	1,408	3,103	Gr-Honeycomb
TPS	2,609	5,751	TABVACC
Engine Heat Shields (4)	347	764	
D-57A Eng (2)	1,518	3,346	
RS-27A Eng (2)	2,218	4,888	
TVC	328	724	
Pressure and Feed System	2,376	5,238	
RCS/OMS	907	2,000	Delta Clipper
Avionics	1,361	3,000	
Body Flap	181	398	
Landing Gear	852	1,878	F-15
Margin (10%)	2,532	5,581	
Subtotal	27,847	61,390	
Residuals	1,651	3,639	
Total (Stage Cutoff)	29,497	65,029	
Max Usable Propellants	133,250	293,760	
GLOW with Max Usable Propellants	162,747	358,789	

Table C-2. Reference Vehicle Engine Specifications

Engine	D-57A
Manufacturer	Aerojet - LULYKA
Thrust	
Sea Level, lbf	44,000
Vacuum, lbf	80,000
Throttle	17 - 117 percent
Propellants	LOX/LH2
Specific Impulse	
Sea Level, sec	363.2
Vacuum, sec	445.2
Chamber Pressure	1585
Mixture Ratio	5.80
Area Ratio	88
Maximum Duration, sec	1580.0
Thrust Vector Control	+/- 2.5 deg
Start Start Tanks	
Ox Tank Pressurization	TBD
Engine Weight	
Dry, lbs	1673
Wet, lbs	TBD
Diameter, in	63.0
Length, in	112.1
Life	TBD

X-2000 Advanced Technology Demonstrator

Experimental Flight Test Vehicle for SSTO

Structural Design

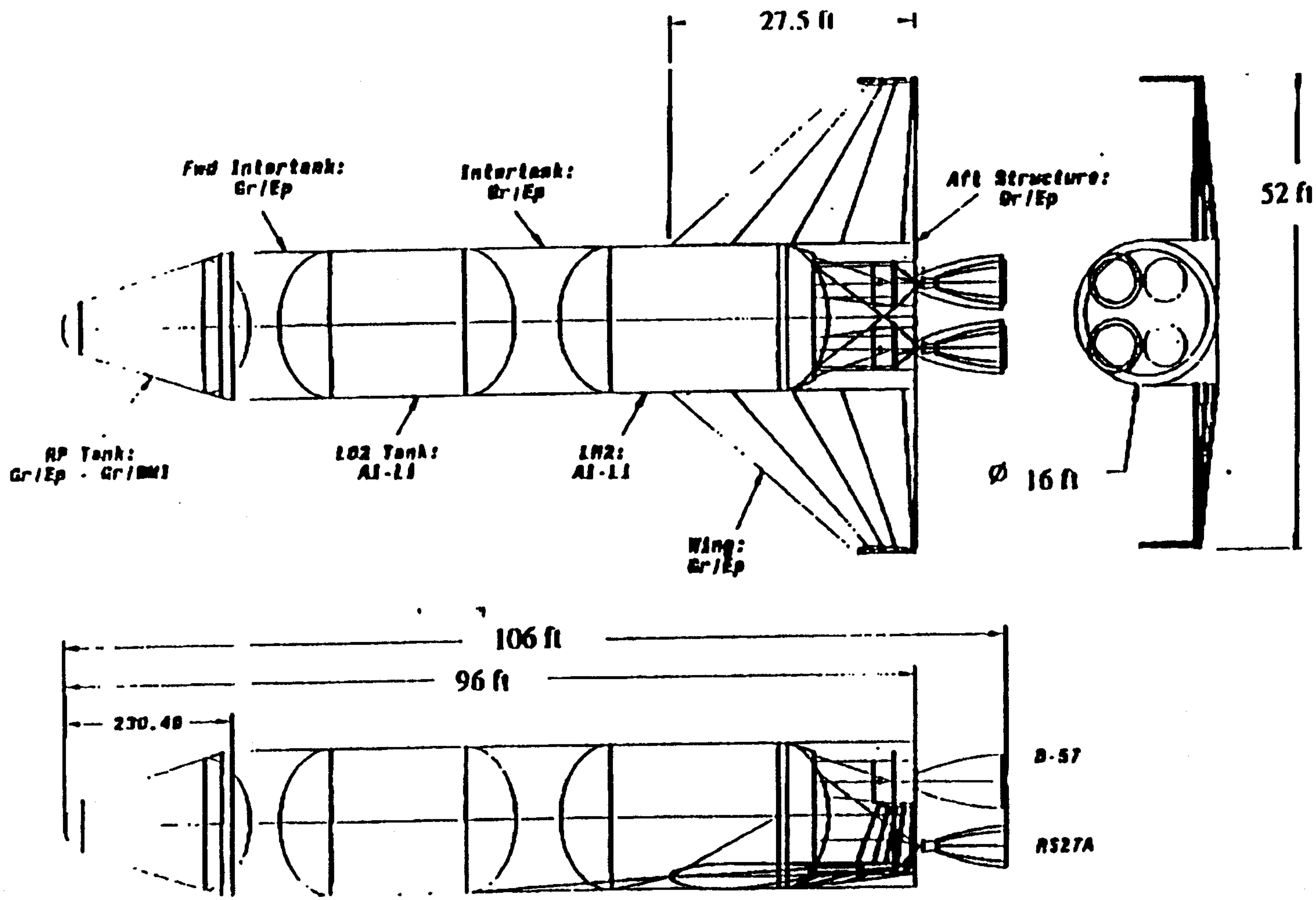


Figure C-1. X-33 Generic Reference Spaceplane Description

APPENDIX D

Preliminary Noise and Sonic Boom Footprints

Appendix D

Preliminary noise contours overlaid to scale on maps of EAFB, WSMR, and ER. Table D-1 is provided to assist in finding a specific map.

Table D-1. Noise Contour Map Index

Rocket Phase	Primary Site	Sound Pressure	Figure Number
Takeoff	EAFB	OASPL	D-1
		dBA	D-2
		dBC	D-3
	WSMR	OASPL	D-4
		dBA	D-5
		dBC	D-6
	ER	OASPL	D-7
		dBA	D-8
		dBC	D-9
Ascent (Moving Vehicle)	EAFB	OASPL	D-10
		dBA	D-11
		dBC	D-12
		24 hour L_{dn}	D-13
		24 hour LC_{dn}	D-14
	WSMR	OASPL	D-15
		dBA	D-16
		dBC	D-17
		24 hour L_{dn}	D-18
		24 hour LC_{dn}	D-19
Flight	EAFB	Sonic Boom (RTTS)	D-20
	WSMR	Sonic Boom (RTTS)	D-21
	EAFB - WSMR	Sonic Boom (Cross Country)	D-22
	EAFB	STS-28 Descent Sonic Boom	D-23

OASPL Overall sound pressure level in decibels (dB)

dBA A-weighted sound level (human perception of sound intensity and frequency)

dBC C-weighted sound level (effects on structures)

L_{dn} Time averaged A-weighted sound levels used to describe annoyance factors on communities

LC_{dn} Time averaged C-weighted sound levels used to describe annoyance factors on communities

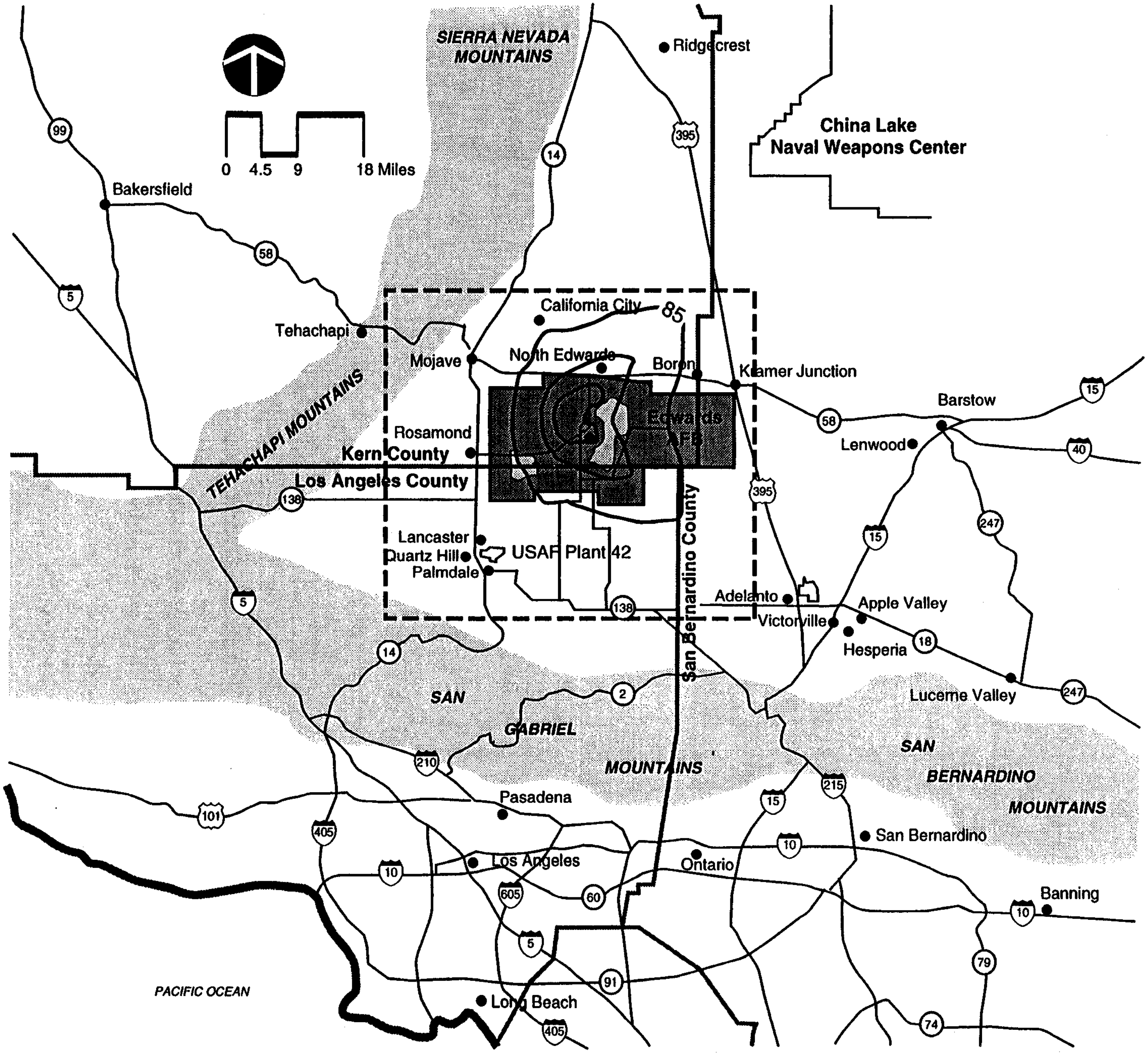


Figure D-1. Overall Sound Pressure Level for the X-33 at Takeoff at EAFB

5-24197

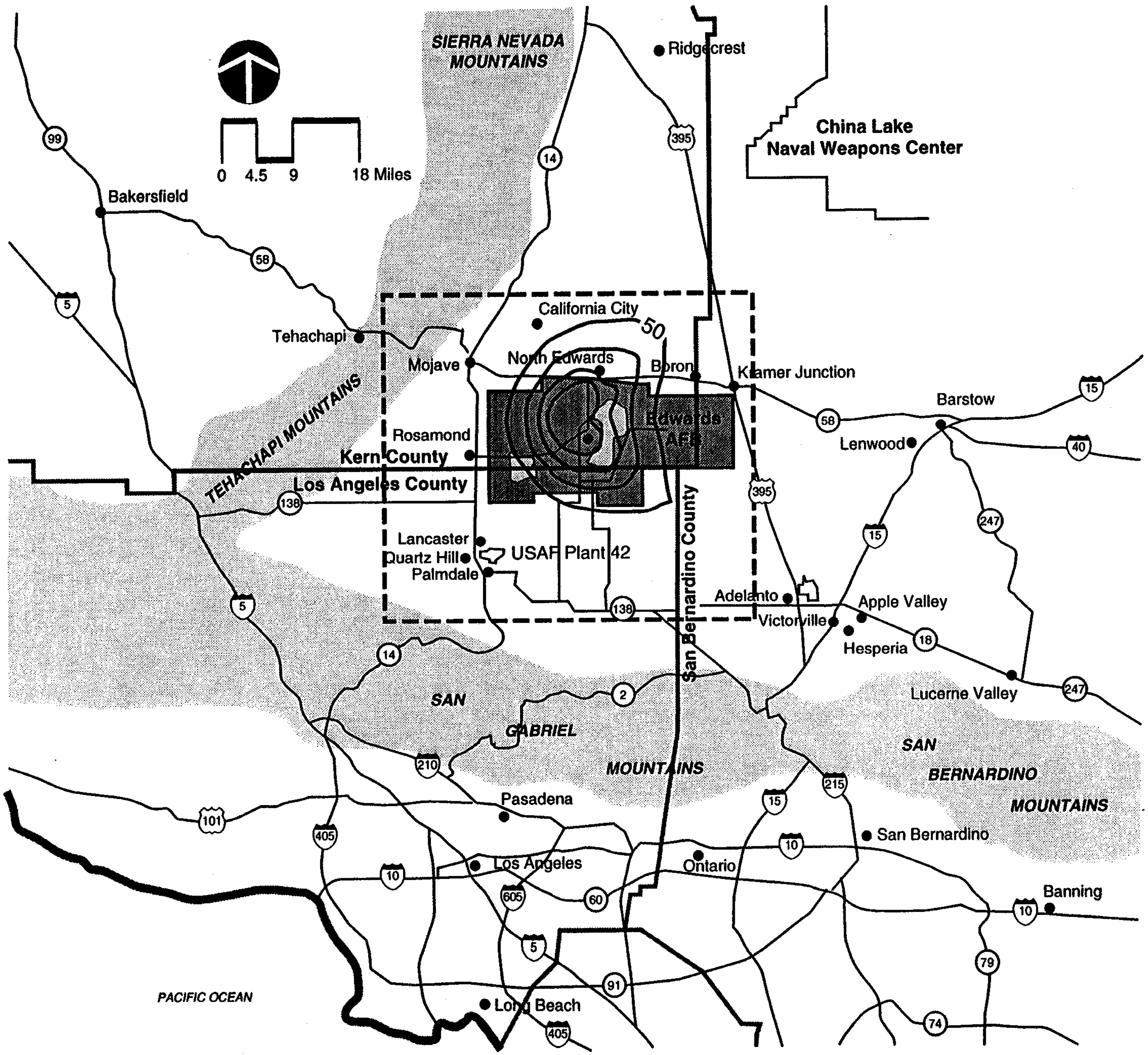


Figure D-2. dBA Weighted Sound Pressure Level for the X-33 at Takeoff at EAFB

5-24195

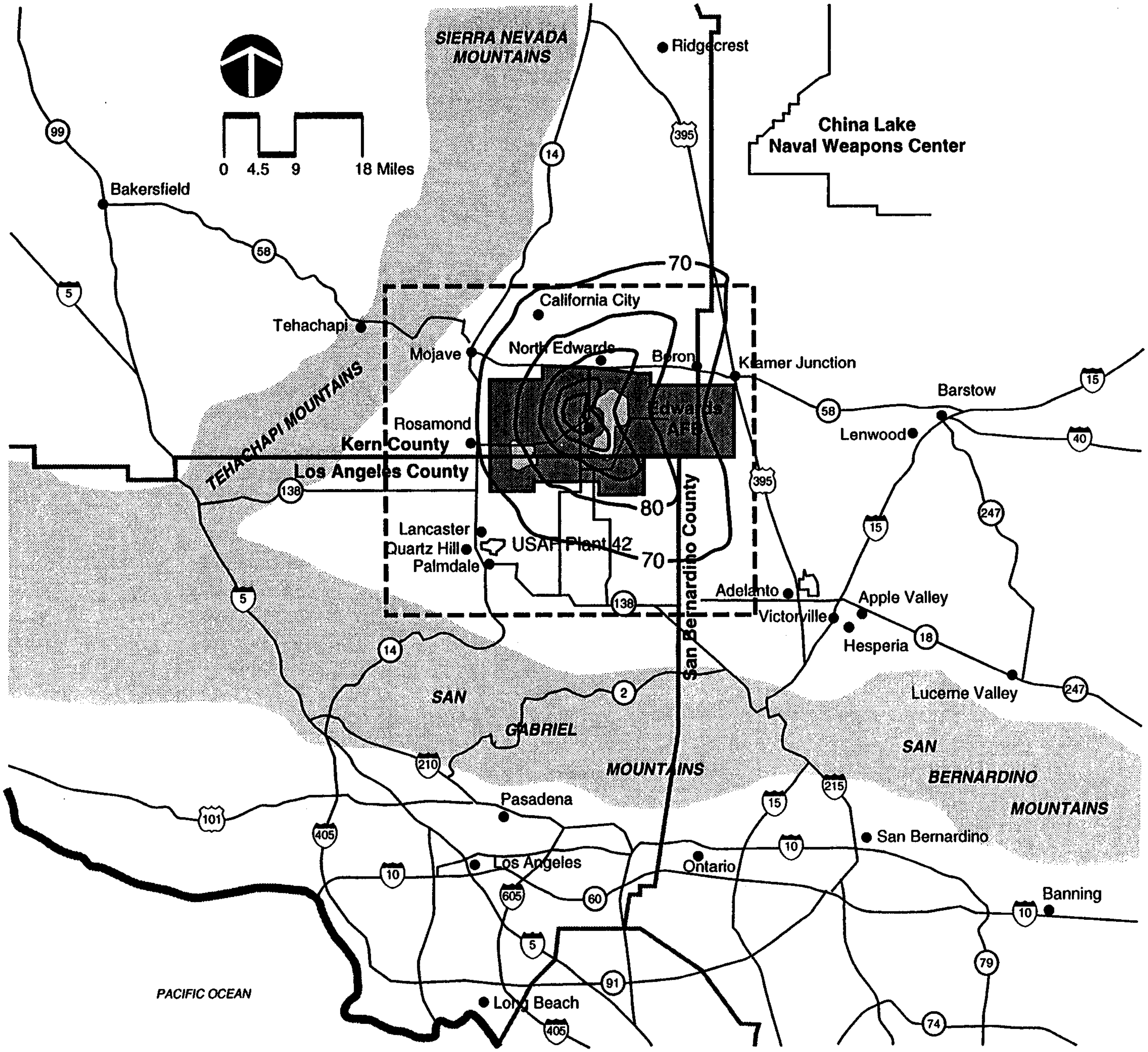


Figure D-3. dBC Weighted Sound Pressure Level for the X-33 at Takeoff at EAFB

5-24196

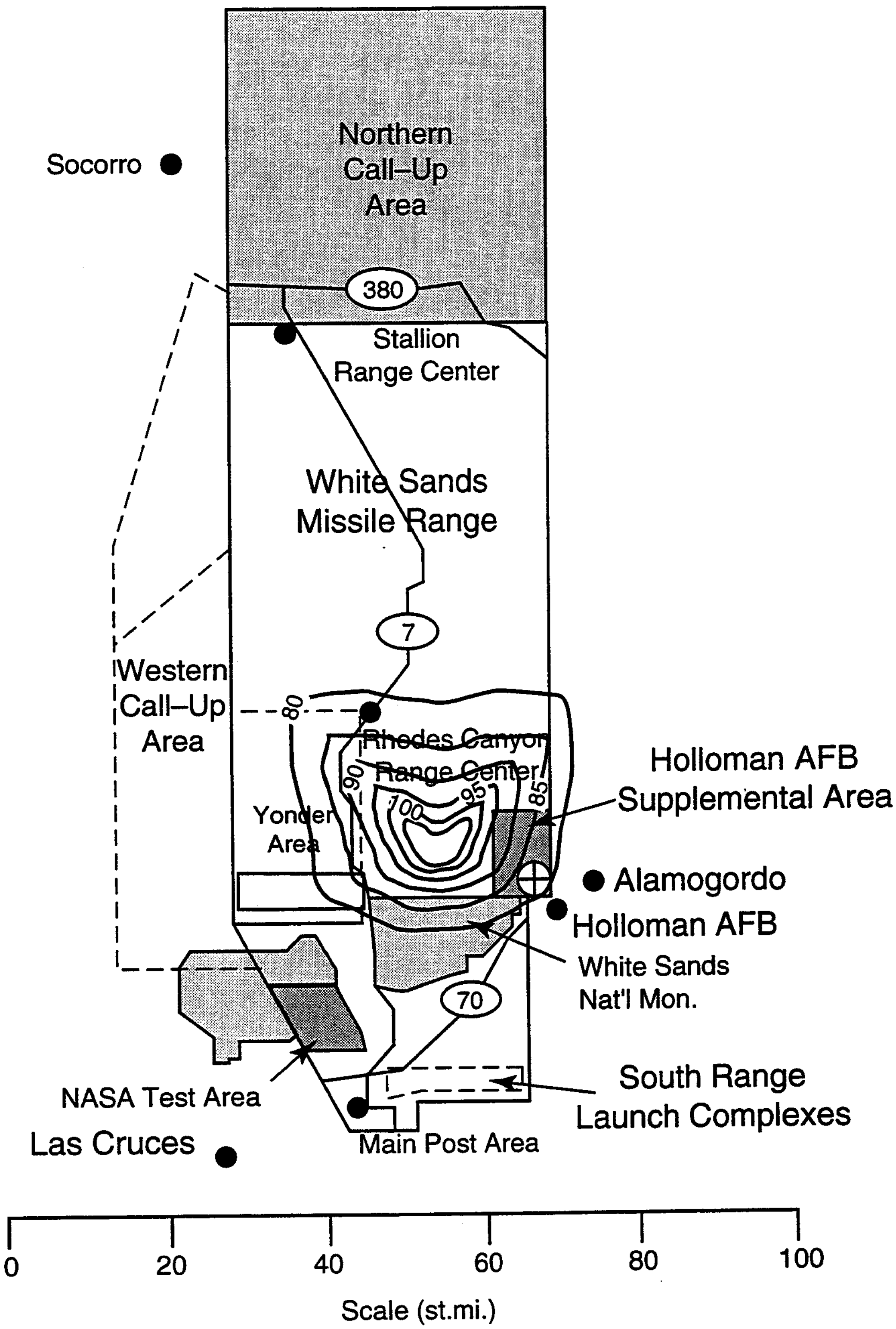


Figure D-4. Overall Sound Pressure Level for the X-33 at Takeoff at WSMR

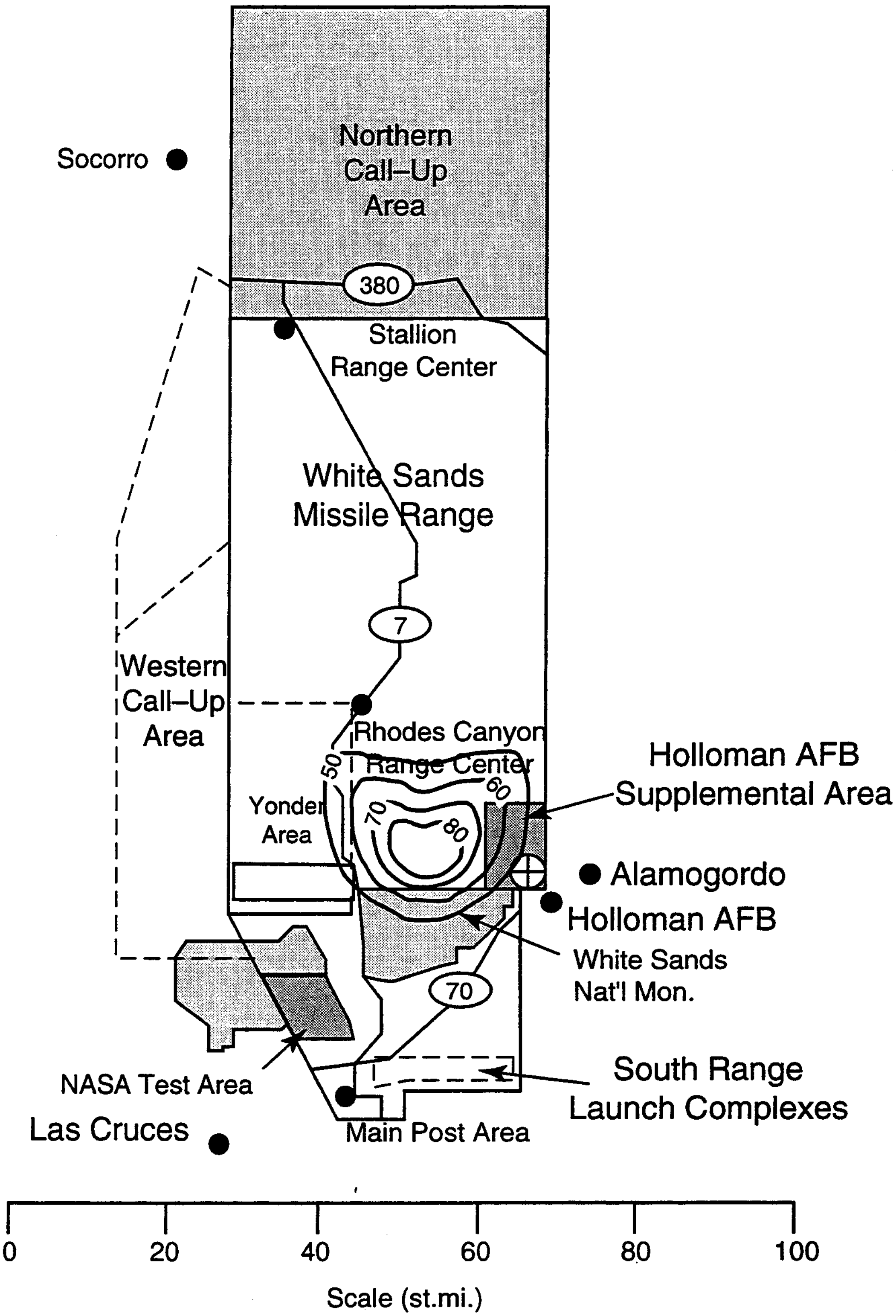


Figure D-5. dBA Weighted Sound Pressure Level for the X-33 at Takeoff at WSMR

5-24199

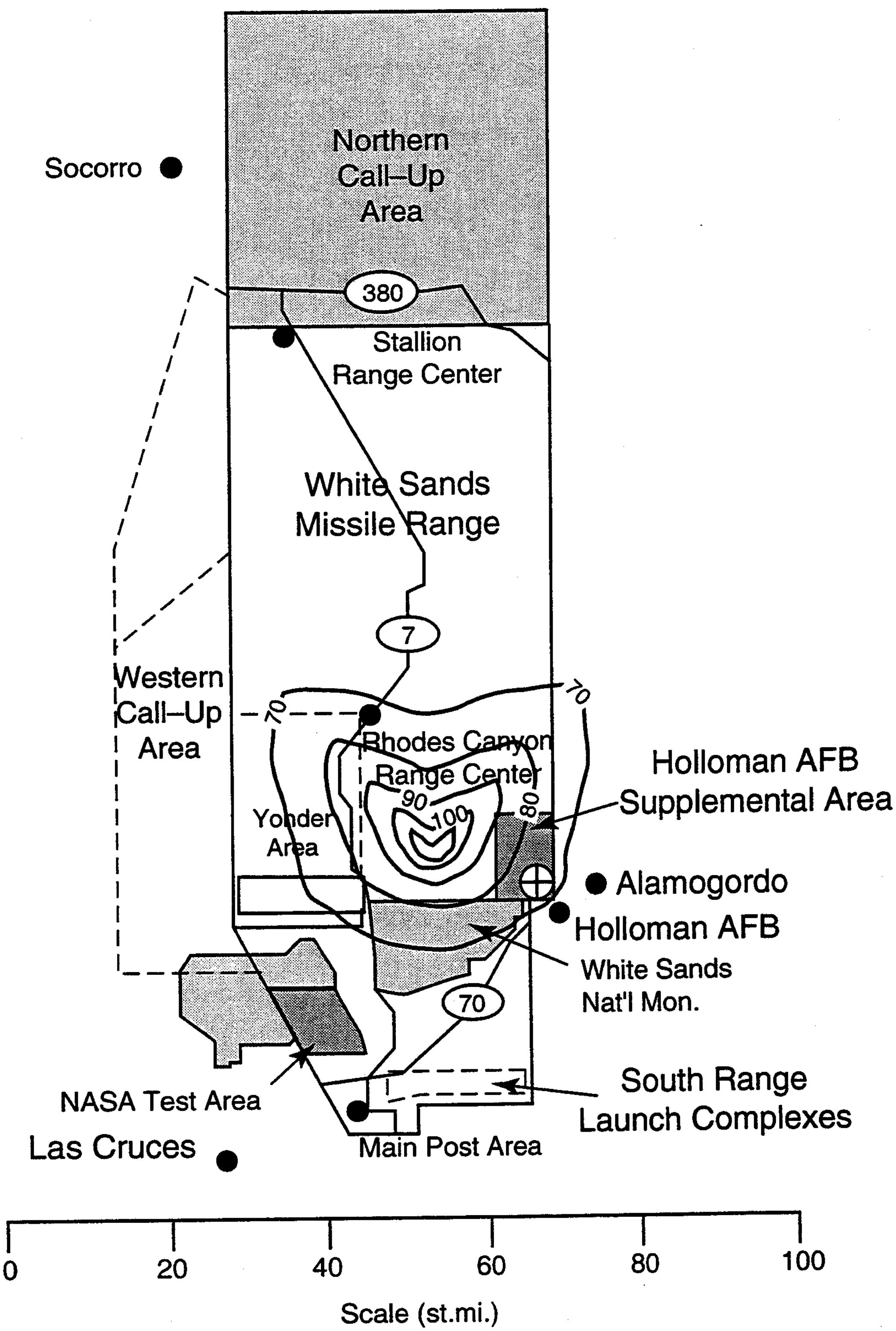


Figure D-6. dBC Weighted Sound Pressure Level for the X-33 at Takeoff at WSMR

5-24215

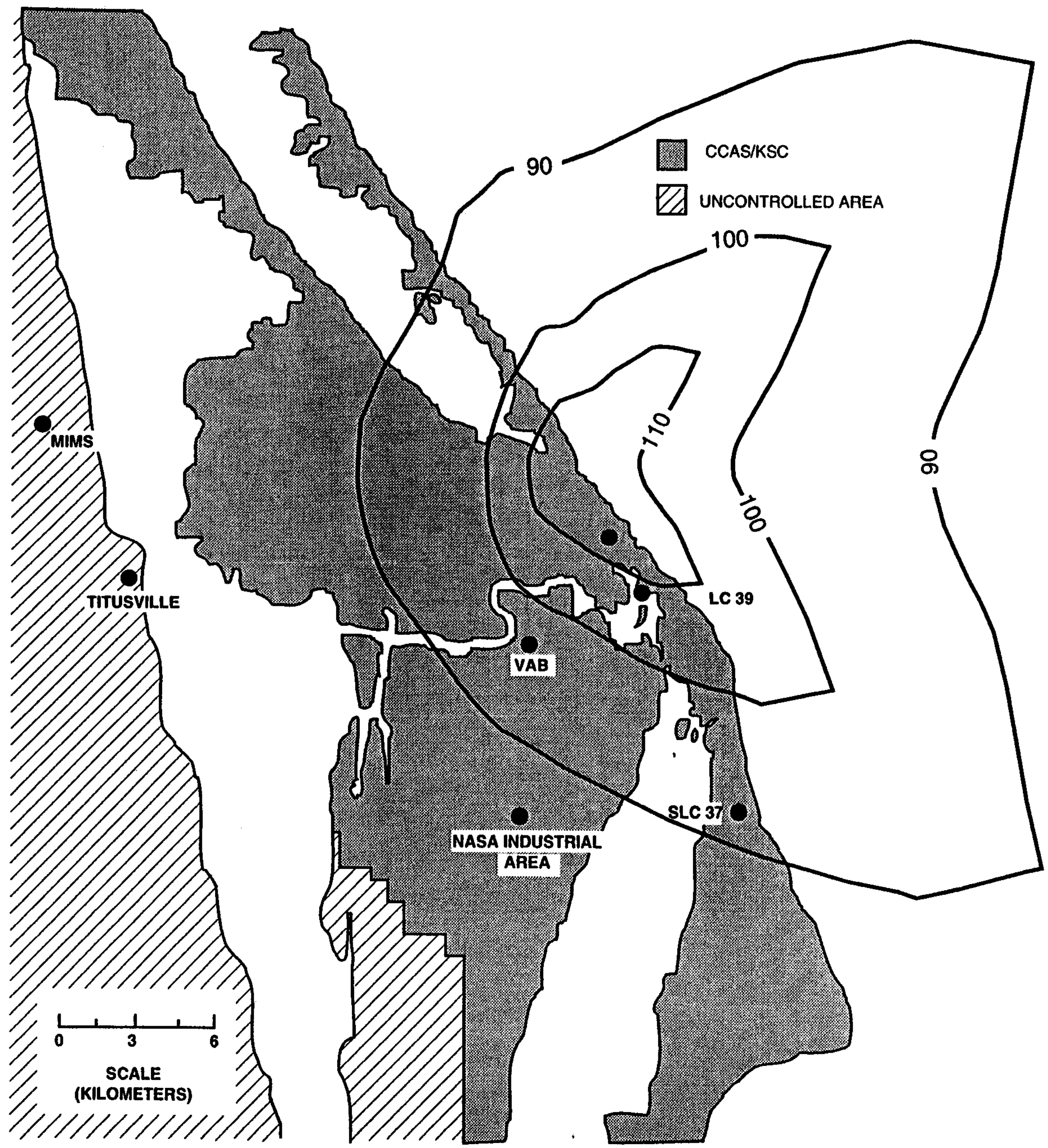


Figure D-7. Overall Sound Pressure Level for the X-33 at Takeoff at the ER

5-24187

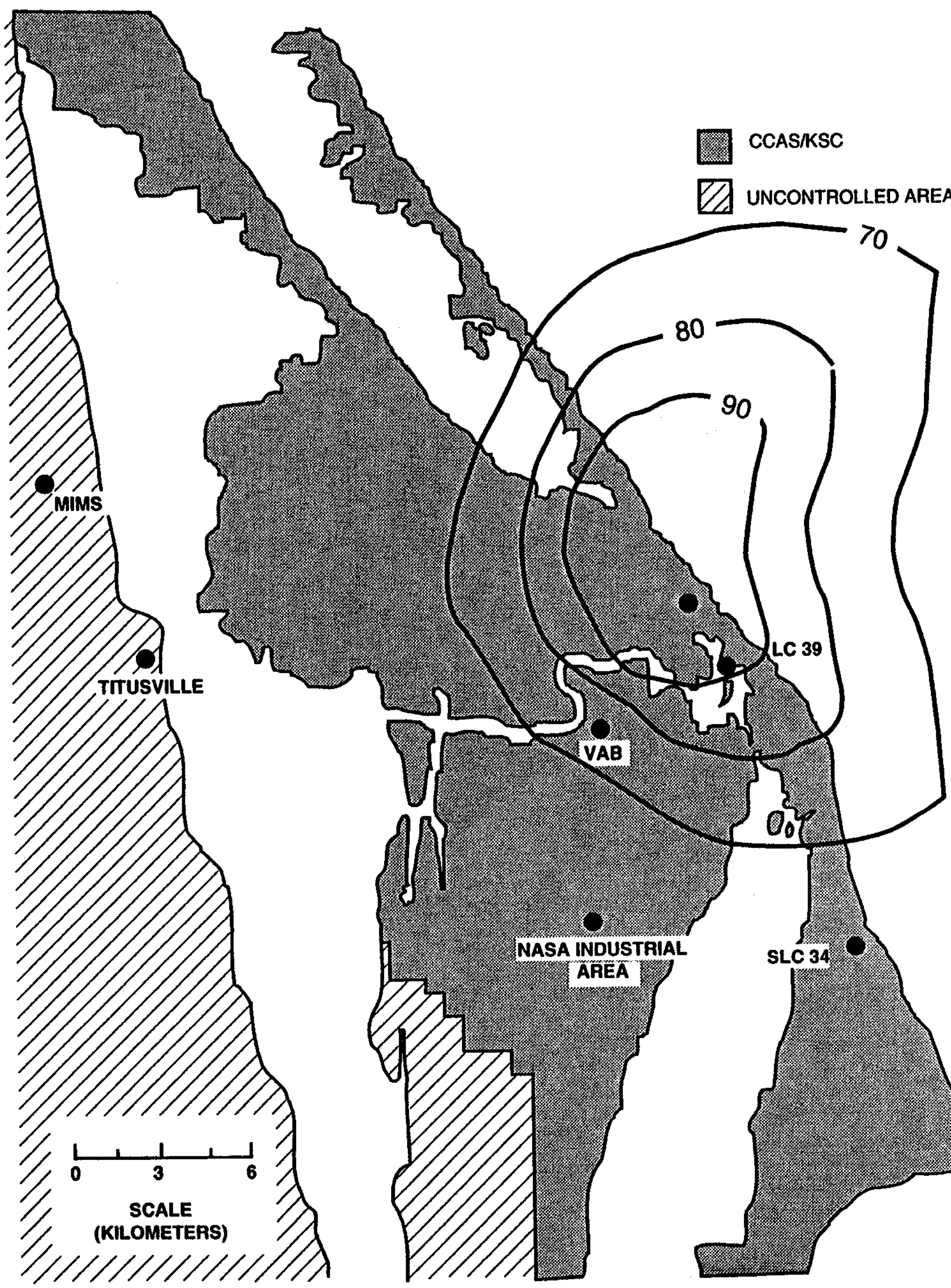


Figure D-8. dBA Weighted Sound Pressure Level for the X-33 at Takeoff at the ER

5-24188

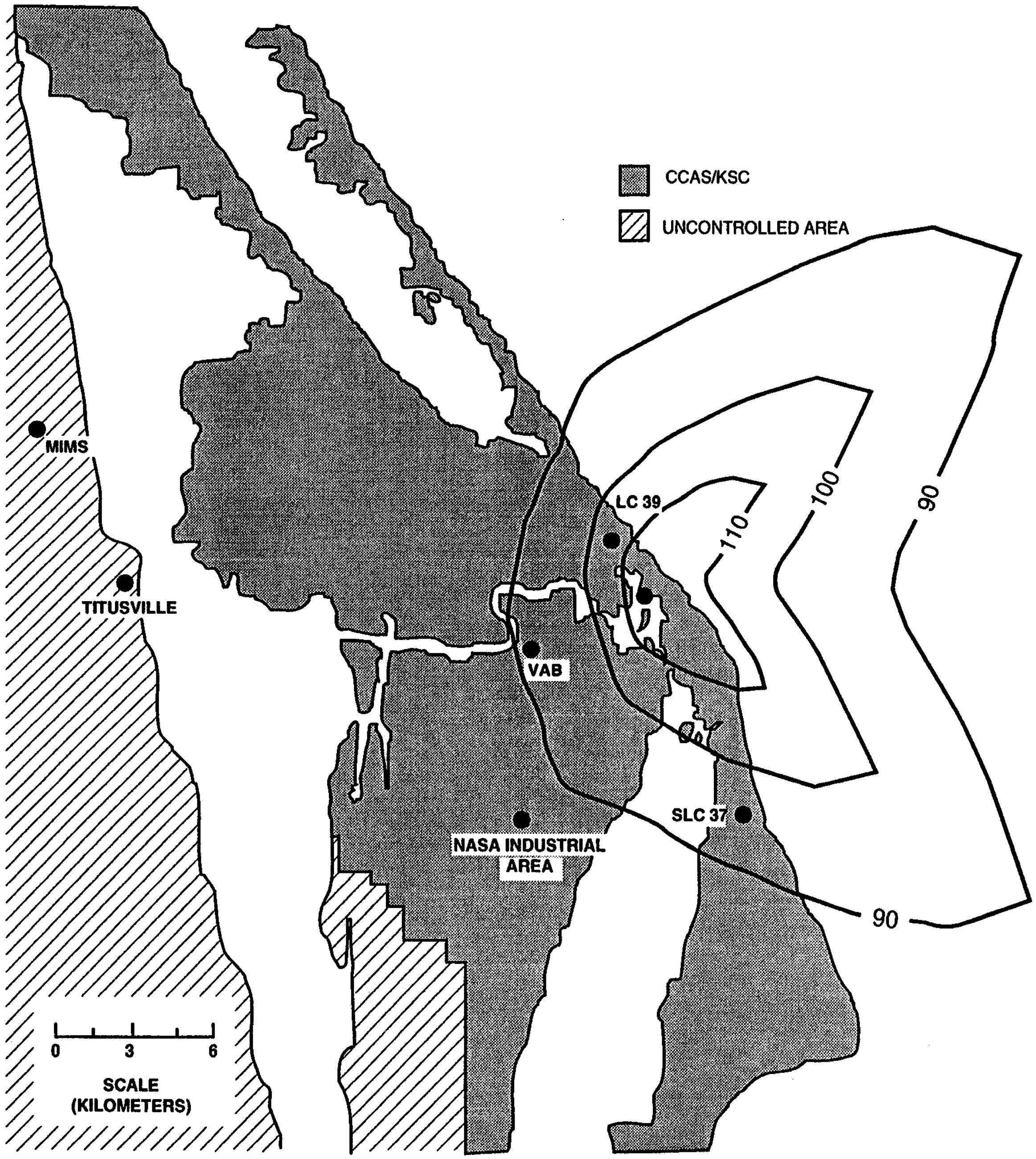


Figure D-9. dBC Weighted Sound Pressure Level for the X-33 at Takeoff at the ER

5-24189

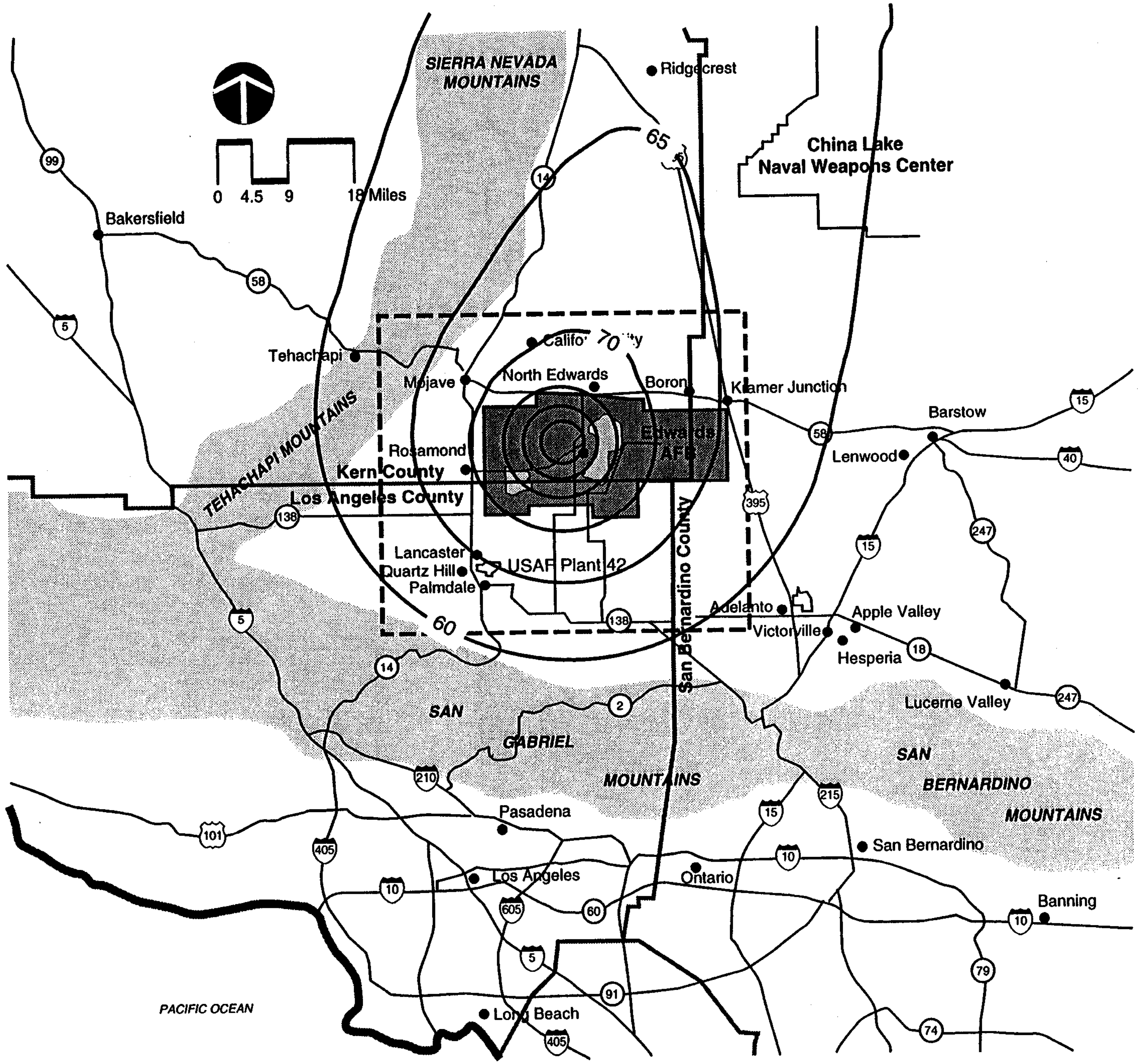


Figure D-10. Overall Sound Pressure Level for the X-33 During Takeoff at EAFB

5-24194

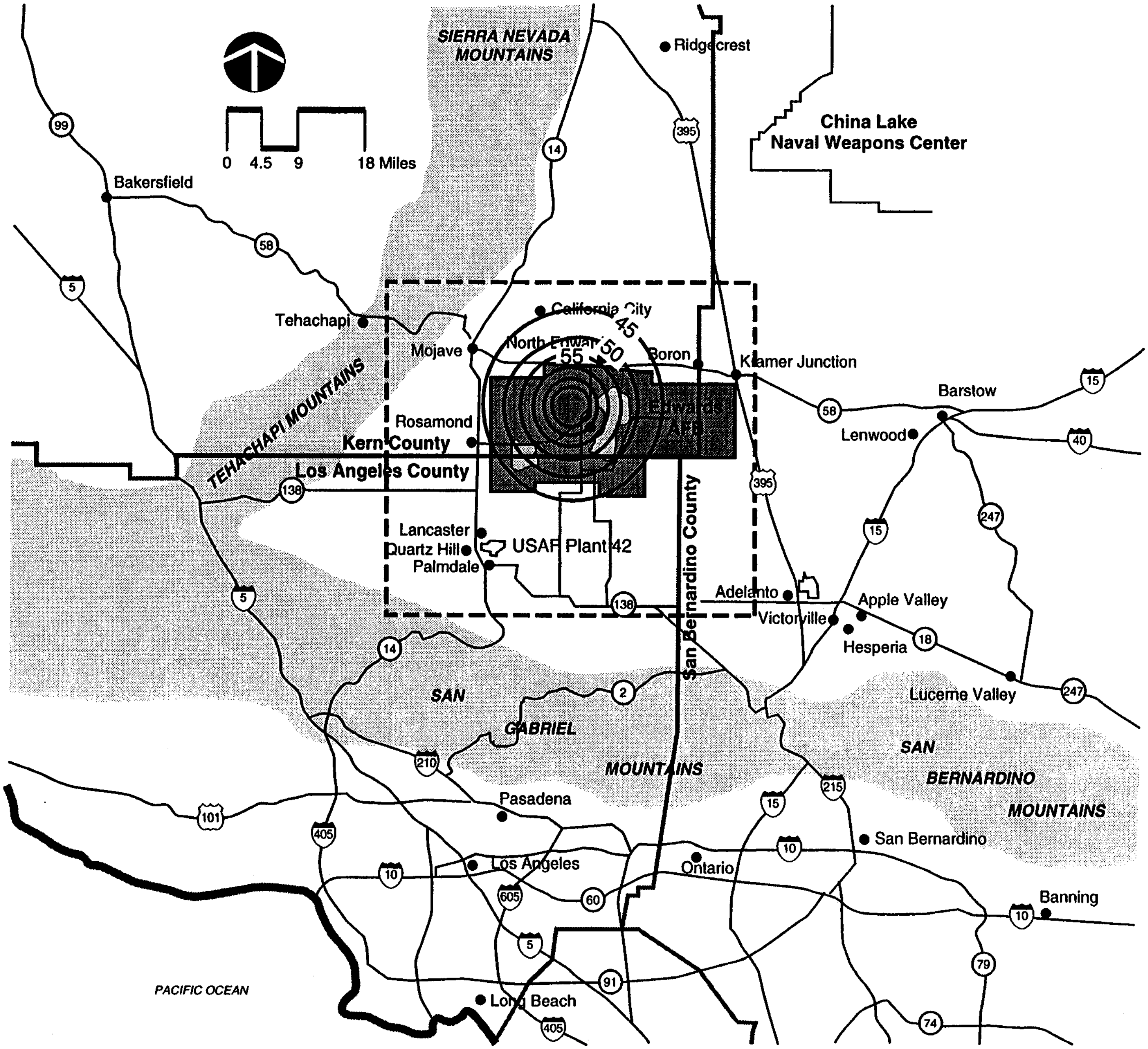


Figure D-11. dBA Weighted Sound Pressure Level for the X-33 During Takeoff at EAFB

5-24193

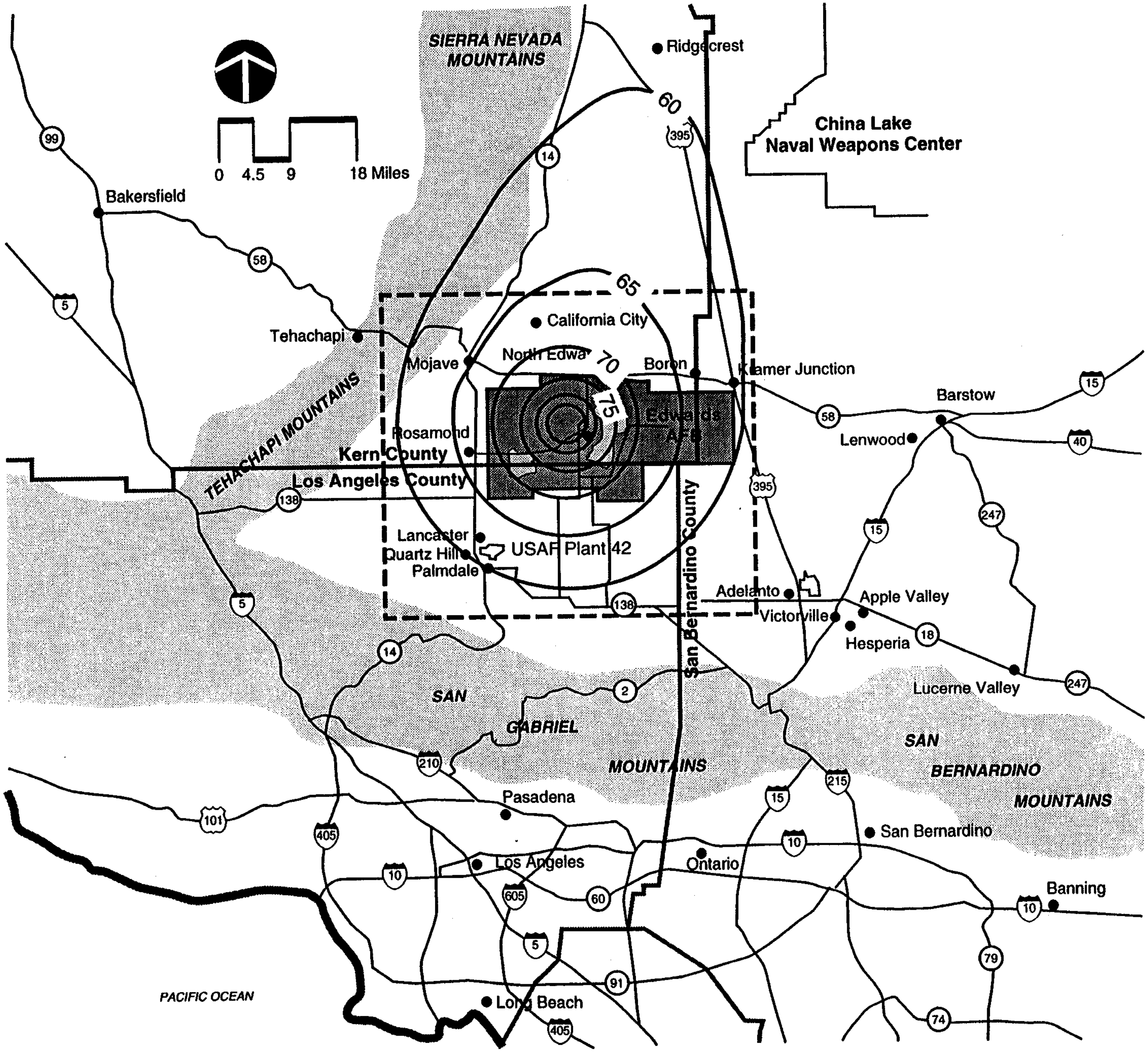


Figure D-12. dBC Weighted Sound Pressure Level for the X-33 During Takeoff at EAFB

5-24192

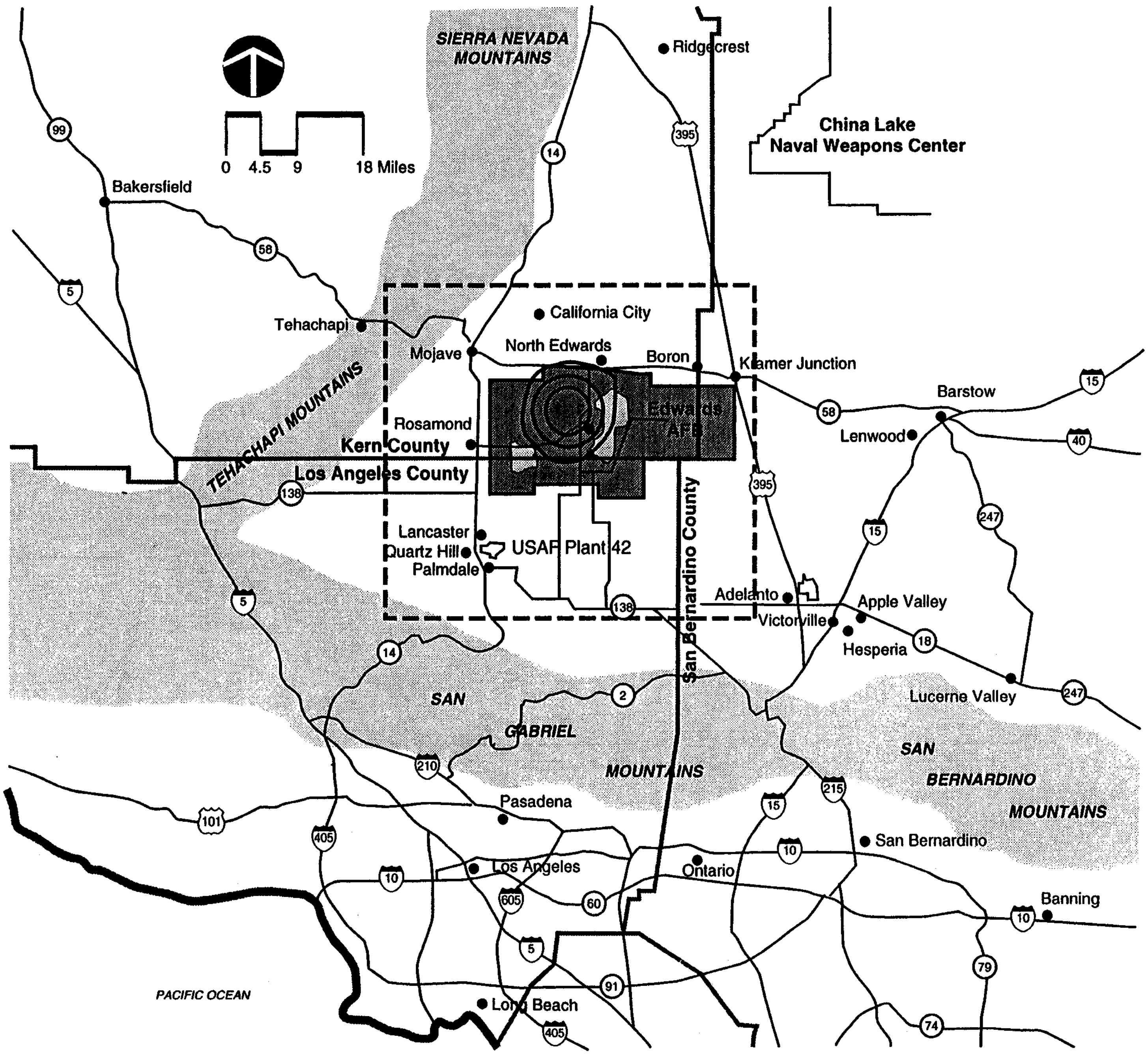


Figure D-13. A-Weighted 24 Hour Day-Night Average Sound Level for the X-33 During Takeoff at EAFB

5-24191

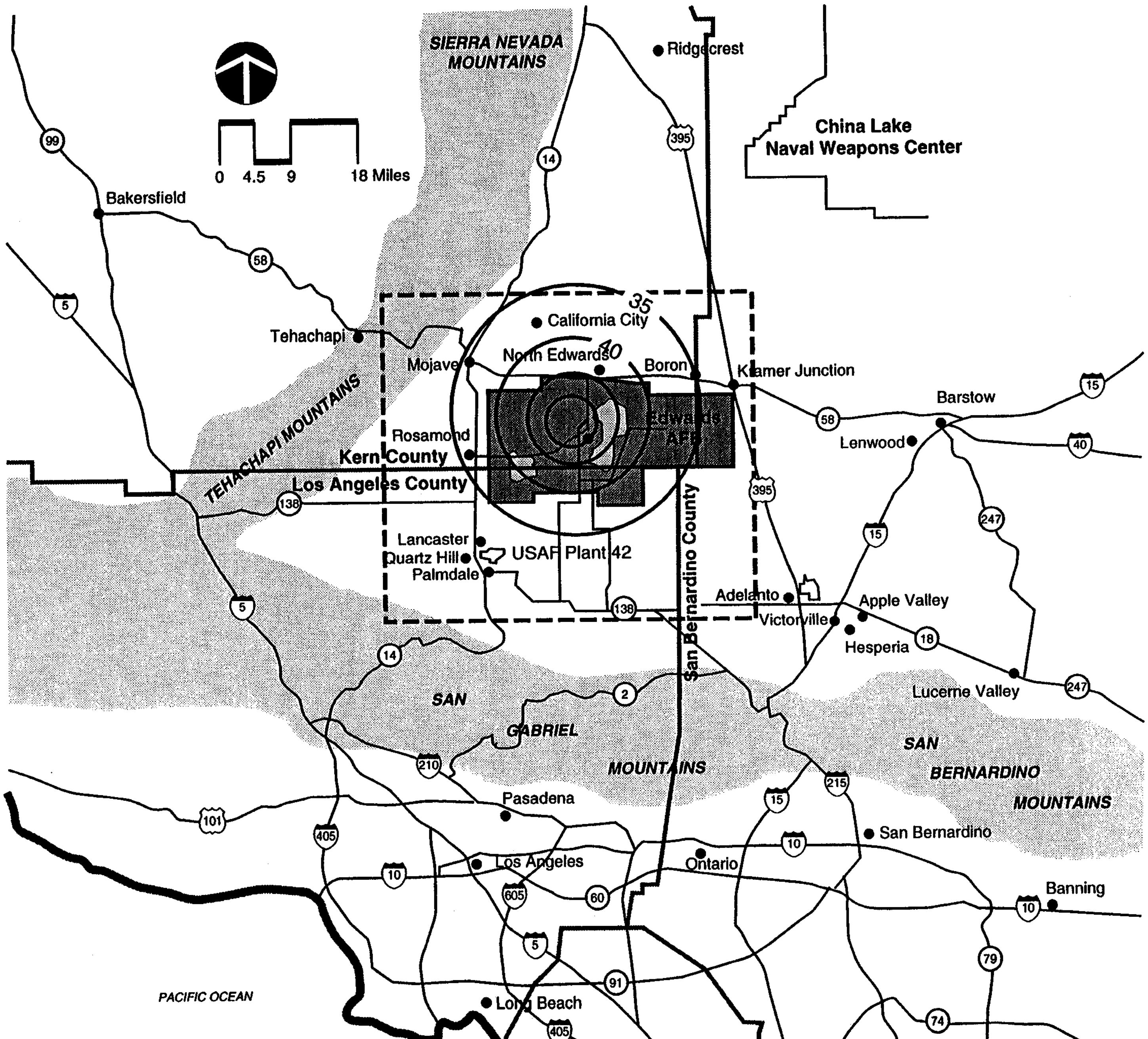


Figure D-14. C-Weighted 24 Hour Day-Night Average Sound Level for the X-33 During Takeoff at EAFB

5-24190

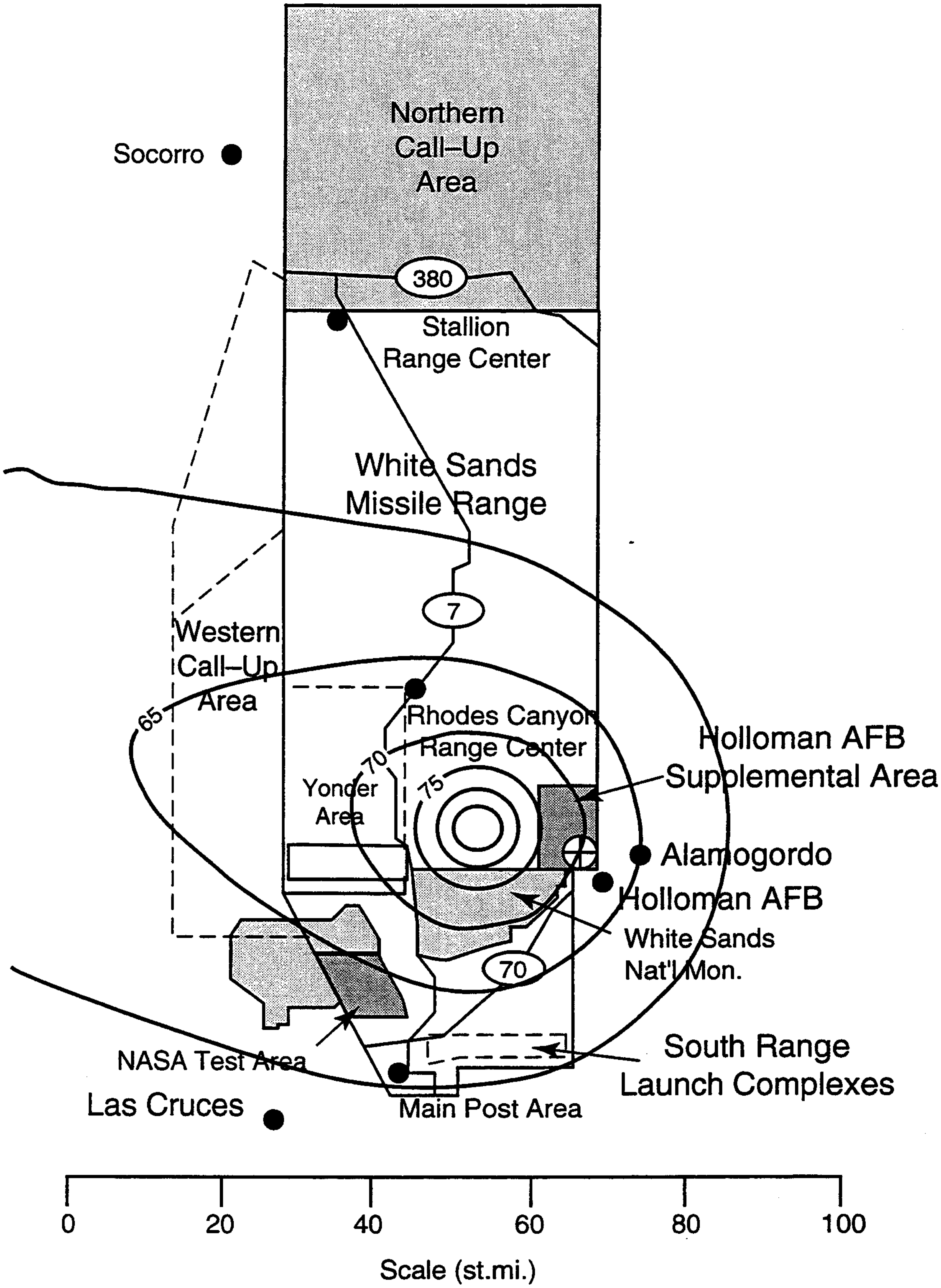


Figure D-15. Overall Sound Pressure Level for the X-33 During Takeoff at WSMR

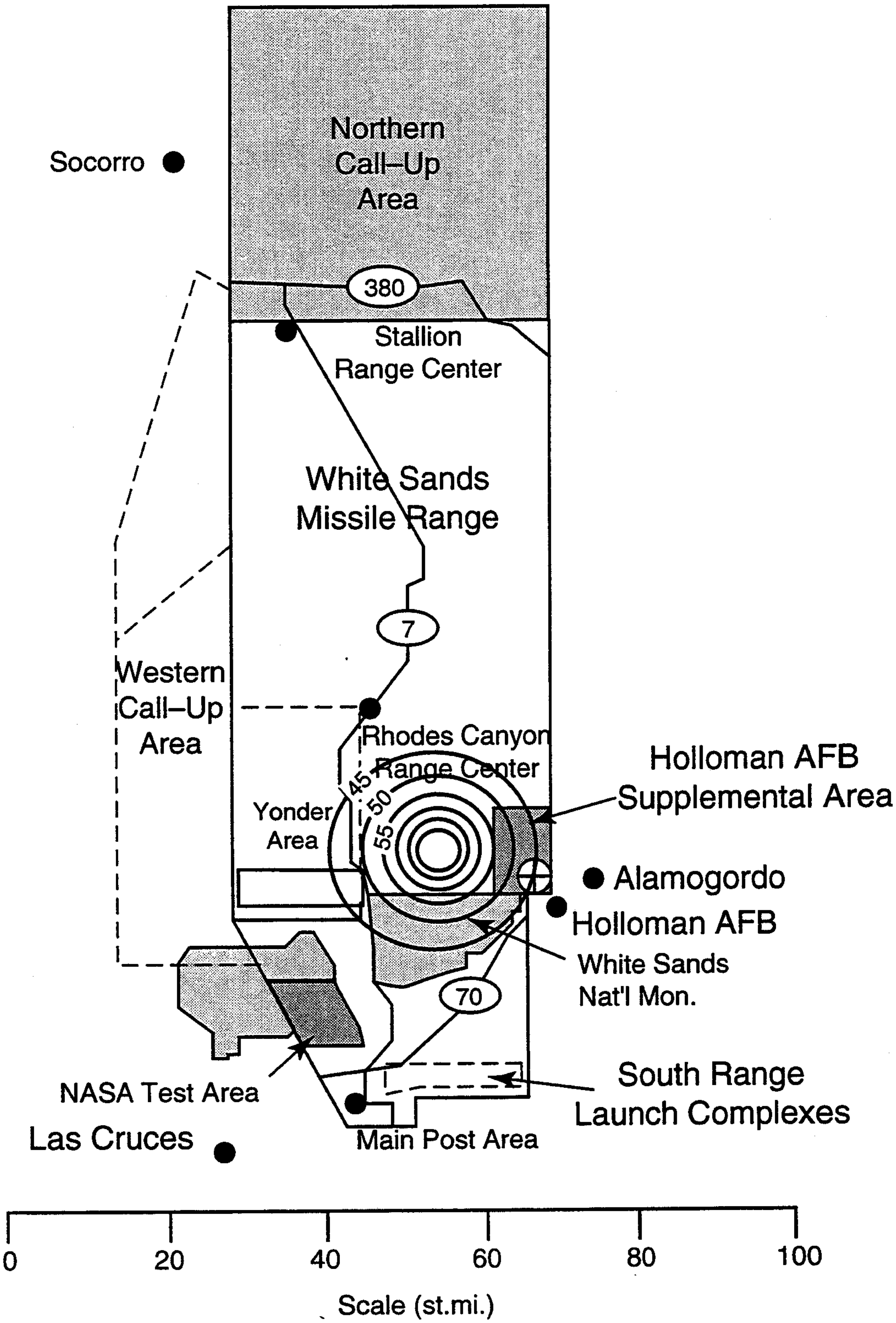


Figure D-16. dBA Weighted Sound Pressure Level for the X-33 During Takeoff at WSMR

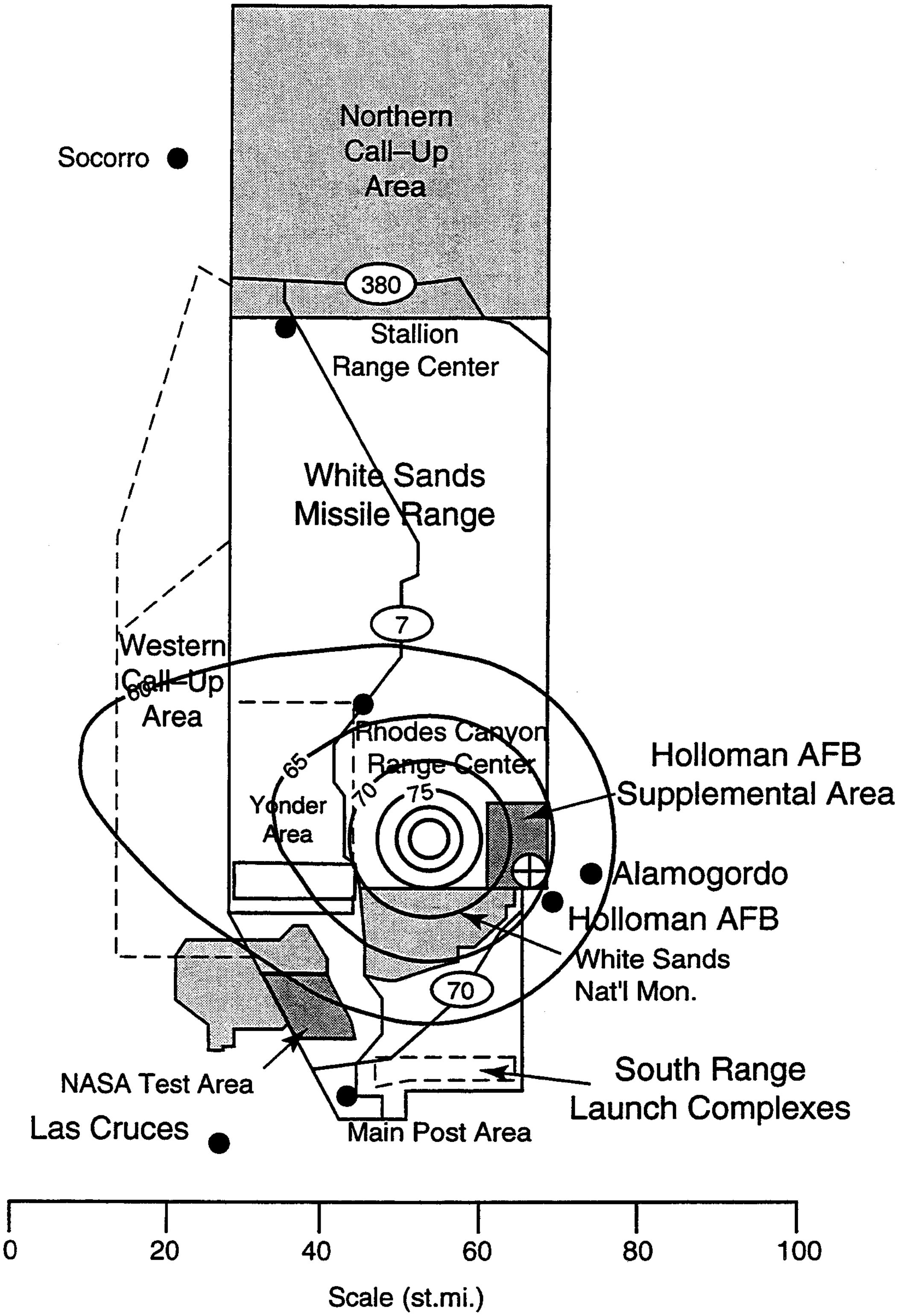


Figure D-17. dBC Weighted Sound Pressure Level for the X-33 During Takeoff at WSMR

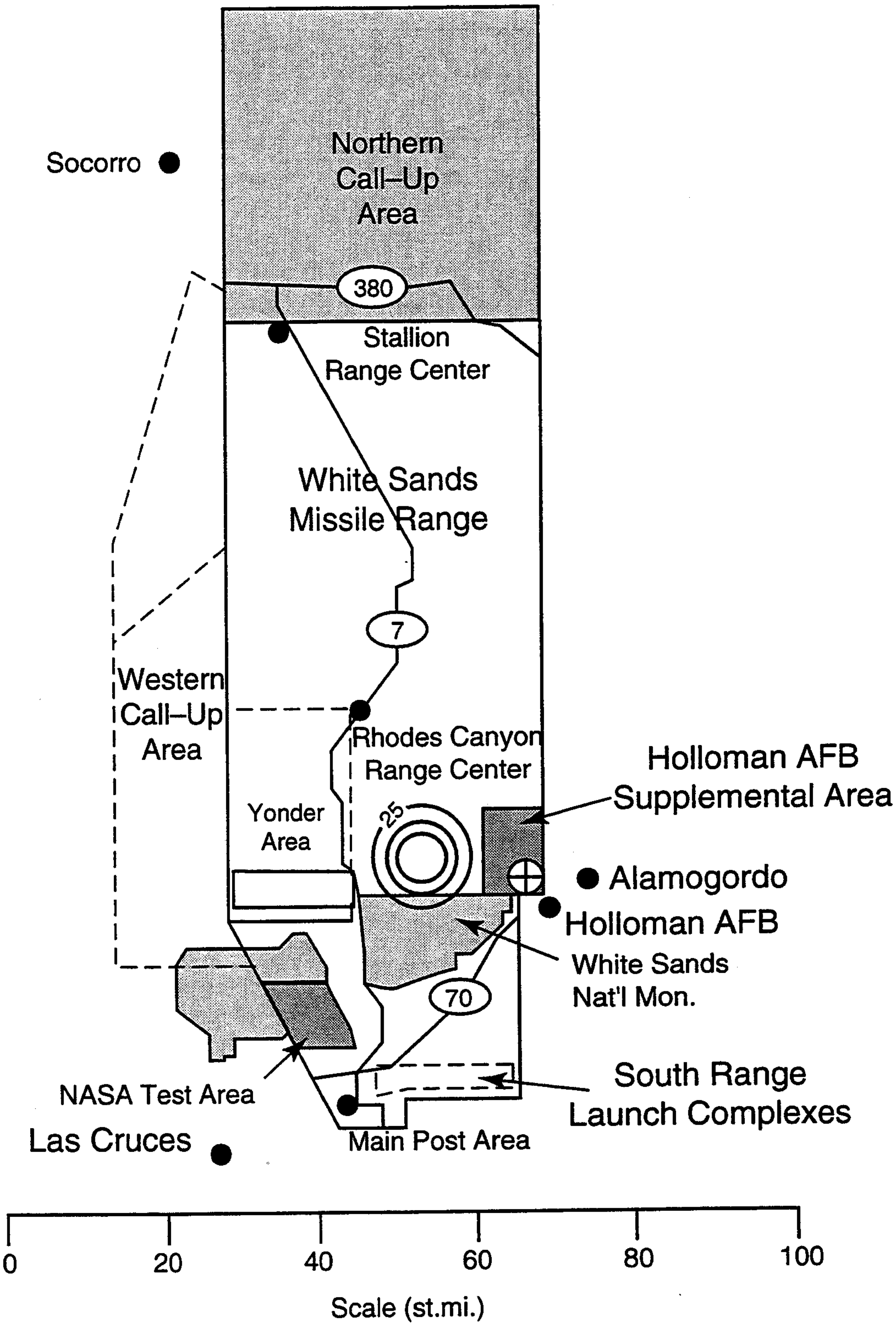


Figure D-18. A-Weighted Hour Day-Night Average Sound Pressure Level for the X-33 During Takeoff at WSMR

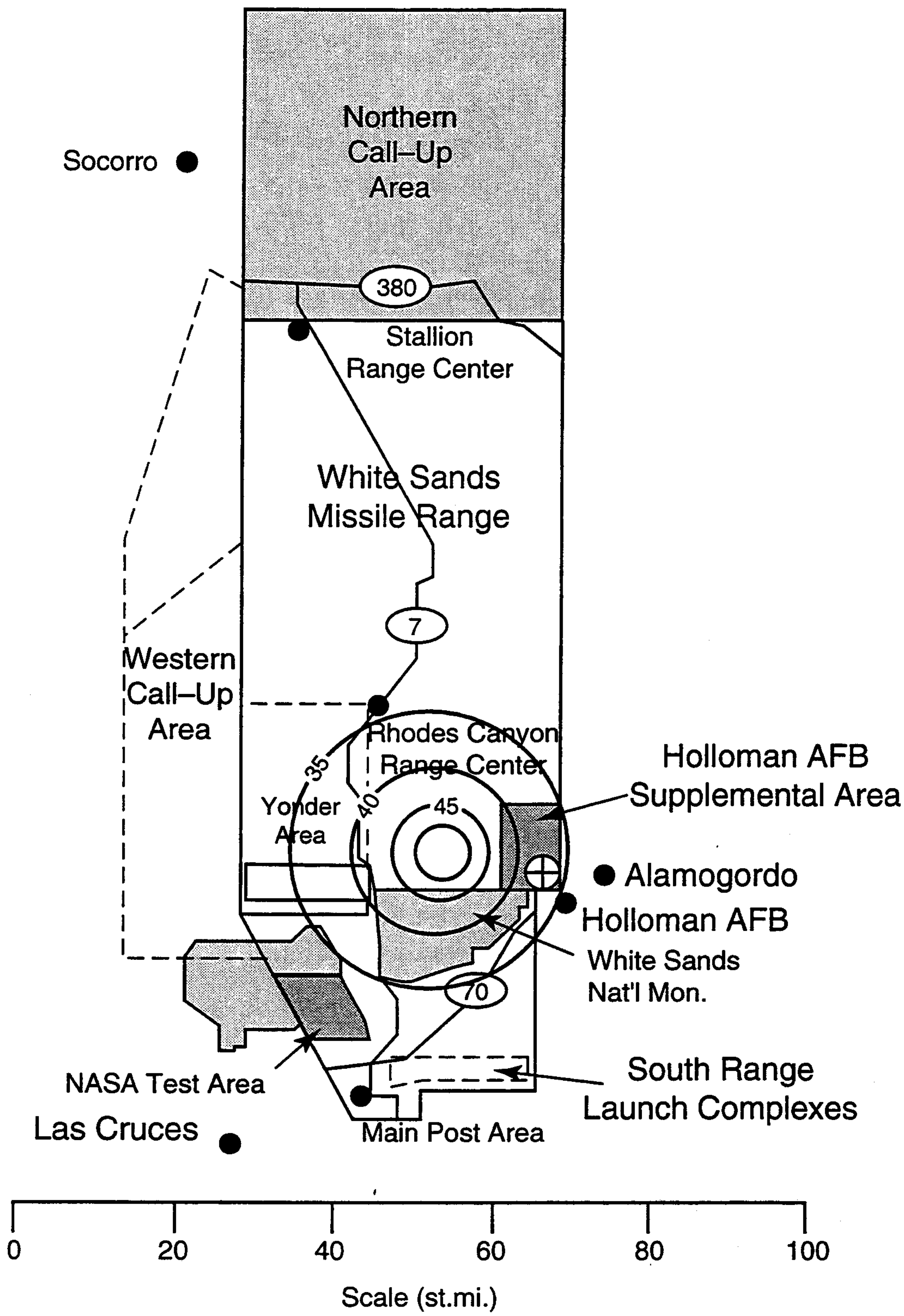


Figure D-19. C-Weighted 24 Hour Day-Night Average Sound Pressure Level for the X-33 During Takeoff at WSMR

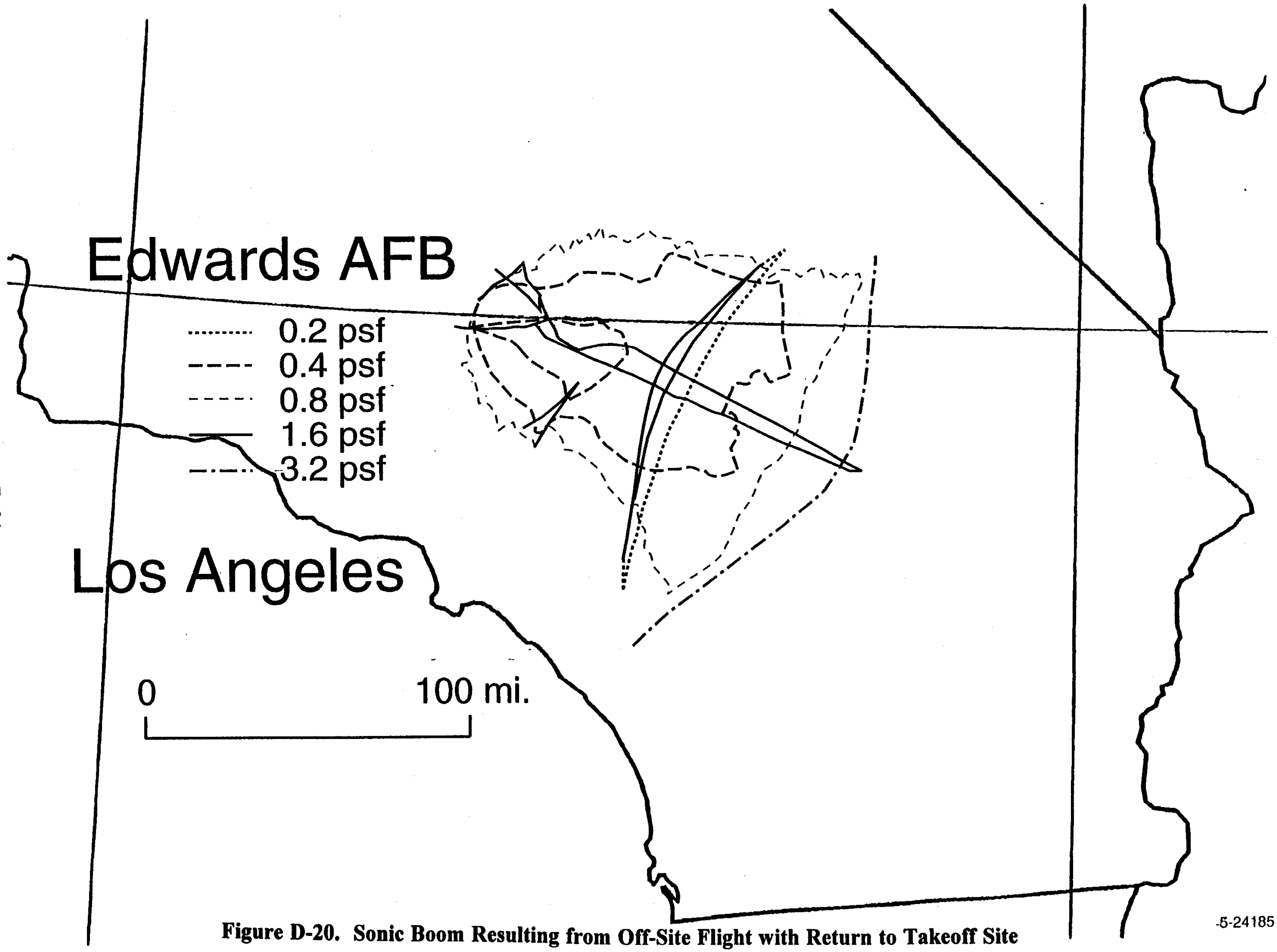


Figure D-20. Sonic Boom Resulting from Off-Site Flight with Return to Takeoff Site at EAFB

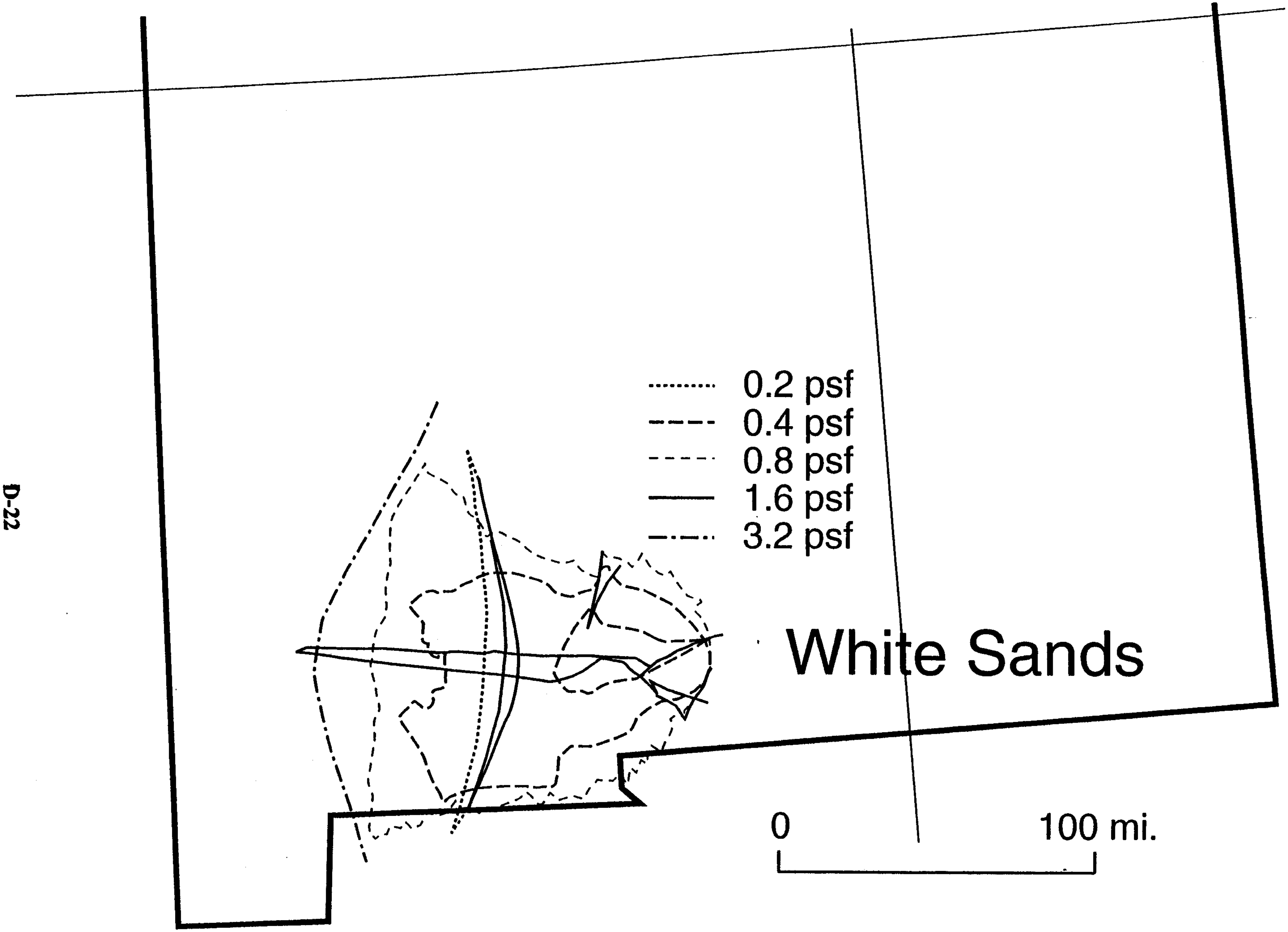


Figure D-21. Sonic Boom Resulting from Off-Site Flight with Return to Takeoff Site at WSMR

5-24186

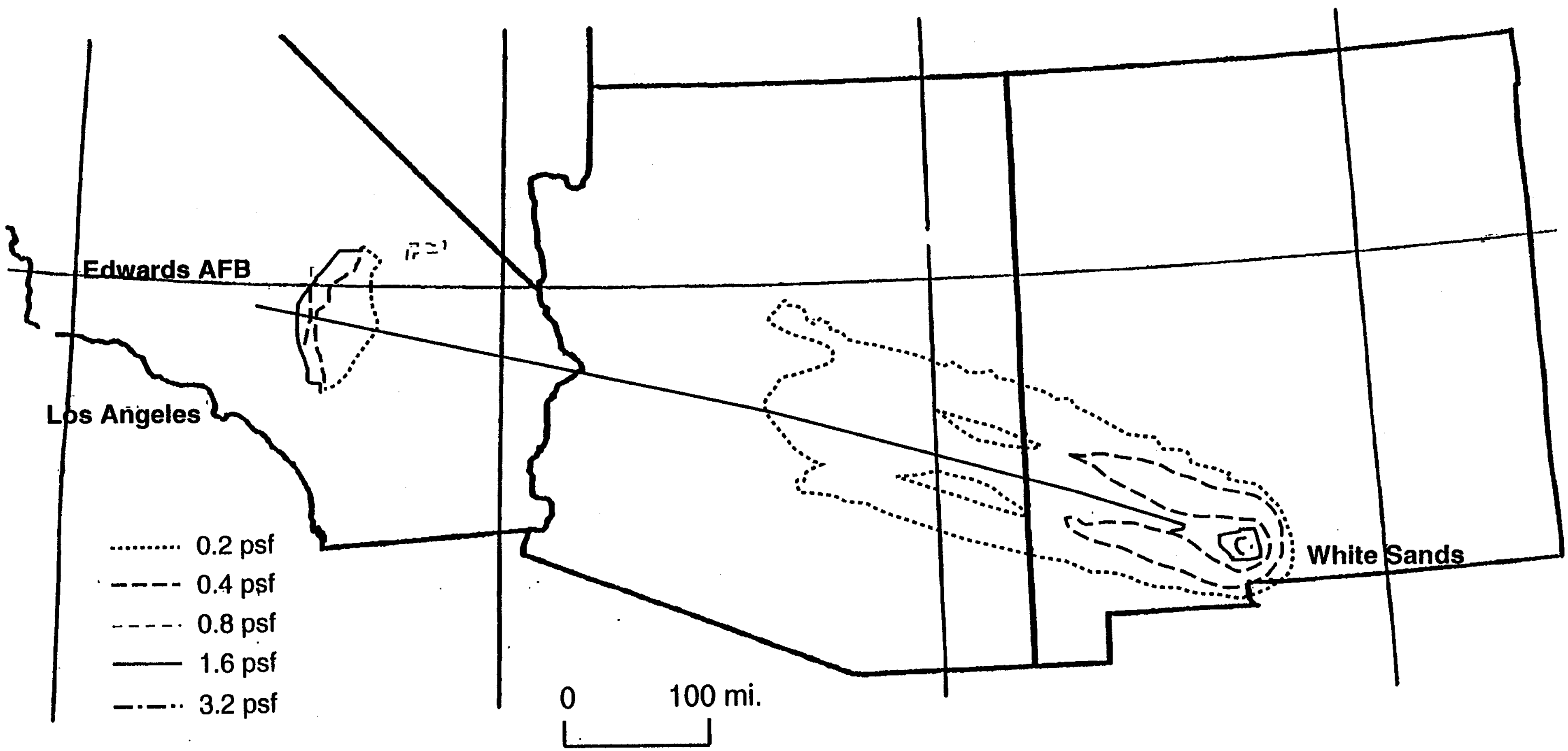
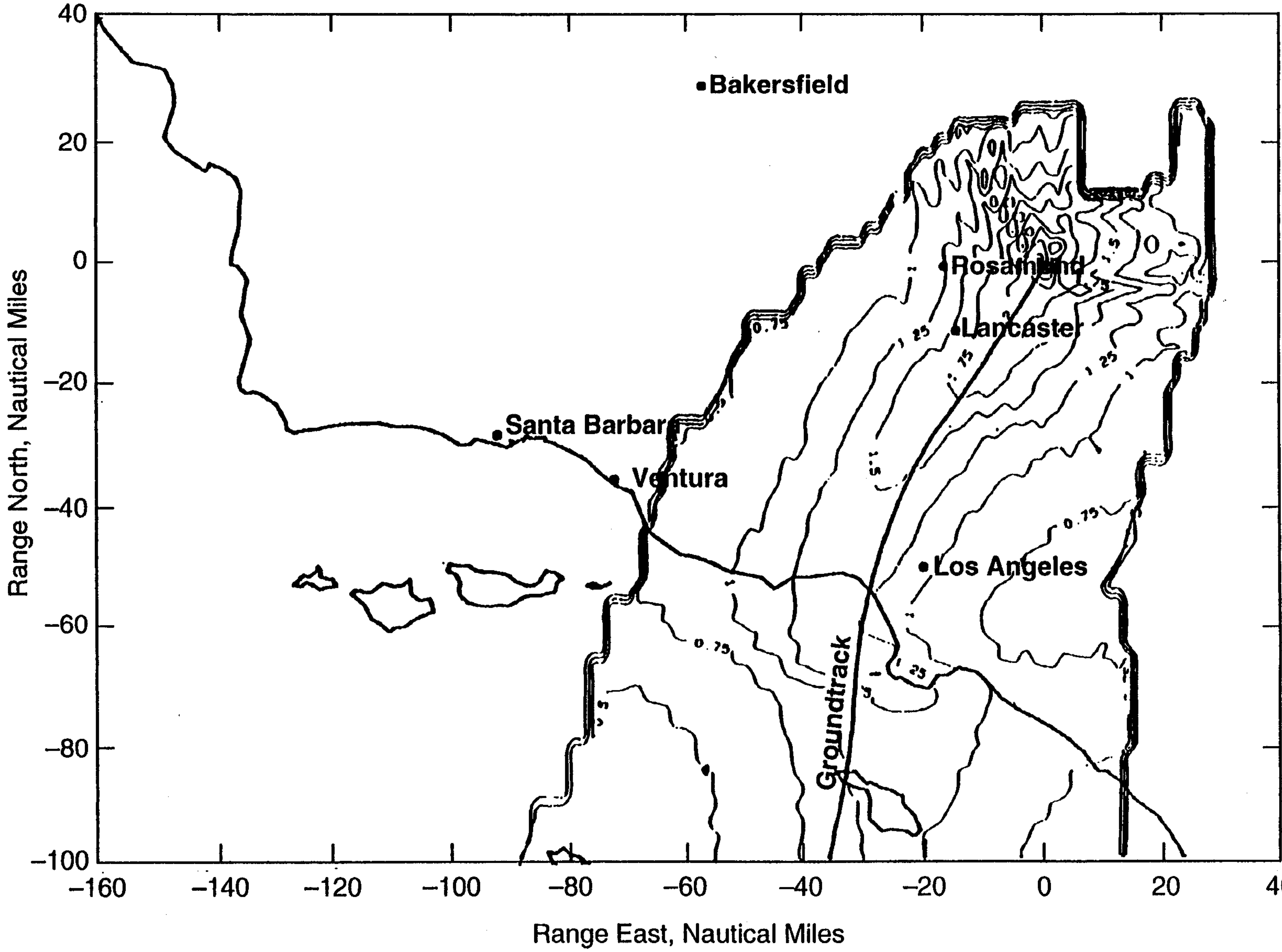


Figure D-22. Sonic Boom Resulting from Off-Site Flight Between EAFB and WSMR

5-24184

STS–28 DESCENT SONIC BOOM
STANDARD ATMOSPHERE – NO WINDS



"Descent Sonic Boom Measurements for STS–28", E. Stansbery and J. Stanley, JSC, Oct. 1989

Figure D-23. STS-28 Descent Sonic Boom

5-24183

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